GEOTECHNICAL INVESTIGATION
FY2012 LIFT STATION
RENEWAL AND REPLACEMENT
NORTHBROOK, HARDY TEMP
HUNTERWOOD AND HARVEST MOON
WBS NO. R-000267-0111-3
HOUSTON, TEXAS

GEI REPORT NO. 1140194901

Reported to:

ARCADIS U.S., INC.

Houston, Texas

Submitted by:

GEOTEST ENGINEERING, INC.

Houston, Texas

February 7, 2014

Key Map Nos. 488 M, 453 D, 456 K & 570 R

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Report No. 1140194901
February 7, 2014

Mr. Edward Quiroz, P.E.
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Houston, Texas 77042

Reference: Geotechnical Investigation
FY2012 Lift Station Renewal and Replacement
Northbrook Lift Station, Hardy Temp Lift Station,
Hunterwood Lift Station and Harvest Moon Lift Station
WBS No. R-000267-0111-3
Houston, Texas

Dear Mr. Quiroz:

Presented herein is the final geotechnical investigation report for the referenced project. A draft report was submitted to you on September 6, 2013. This report supersedes all previously submitted reports, transmittals, etc. for the referenced project. This study was authorized by ARCADIS U.S., Inc. by Work Authorization No. 05142013-01 dated May 15, 2013 and 06202013-01 dated June 26, 2013.

We appreciate this opportunity to be of service to you. Please call us when we can be of further assistance.

Sincerely,
GEOTEST ENGINEERING, INC.
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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

ILLUSTRATIONS

TABLES

APPENDIX A

APPENDIX B

APPENDIX C

SUMMARY

A geotechnical investigation was conducted in connection with the design and construction of FY 2012 Lift Station Renewal and Replacement project in Houston, Texas. The FY 2012 Lift Station Renewal and Replacement project includes Northbrook Lift Station, Hardy Temp Lift Station, Hunterwood Lift Station and Harvest Moon Lift Station. The detailed project descriptions at each lift station location are presented in Section 1.1 of this report.

The scope of this study included drilling and sampling a total of twelve (12) borings to depths ranging from 15 to 70 feet at various lift station sites, converting two (2) of the borings into piezometers (at Harvest Moon Lift Station site), performing laboratory tests on samples recovered from the borings, reviewing available fault information, performing engineering analyses to develop geotechnical recommendations for FY 2012 renewal and replacement project and preparing a geotechnical report.

The principal findings and conclusions developed from this investigation are summarized as follows:

- Based on review of available fault information, no documented fault was found within the project areas of Northbrook Lift Station, Hardy Temp Lift Station, Hunterwood Lift Station Areas. In Harvest Moon Lift Station area, the Long Point Fault was found to cross the project alignment at Harvest Moon Lane. Hence, a Phase I Geological Fault Study is recommended for the Harvest Moon Lift Station project area. However, it is our understanding that fault studies on Long Point Fault have been performed (by others) for other City of Houston Projects in the general vicinity of Harvest Moon Lift Station area and reports of these studies were made available to the engineer of the record by the City of Houston.

- The existing pavement sections as revealed by the cores/borings drilled through the existing paving consists of 3 inches of asphalt over 6 inches of sand and shell in Northbrook Lift Station, 6 inches of concrete over 6 inches of stabilized sand and shell in

Hunterwood Lift Station. In the Harvest Moon Lift Station area, the existing paving consists of 5.5 to 8 inches of concrete over 0 to 8.5 inches of base material. The base consists of lime stabilized sand and shell and brown sand.

- The subsurface soils below the pavement or existing grade generally consist of cohesive soils, cohesive soils over cohesionless soils, or cohesive soils over intermittent cohesionless soils and cohesive soils within the explored boring depths. The cohesive soils consist of medium stiff to hard dark gray, gray, brown, yellowish brown and reddish brown Fat Clay, Fat Clay with sand, Lean Clay, Lean Clay with sand Sandy Lean Clay. The cohesionless soils consists of loose to very dense reddish brown Silty Sand, Sandy Silt, Silt, Fine Sand with silt and Fine Sand. Surficial fill material consisting of medium stiff to hard dark gray, gray and brown Fat Clay, Sandy Lean Clay, sand with gravel was encountered in borings NBB-1, HTB-1 and HMB-6 below the grade to depths ranging from 4 feet to 15 feet. The detailed description of soils is presented in Section 4.4 of this report.

- The groundwater level measured in all the borings was at depths ranging from 8 to 24 feet during drilling. The groundwater level measured at 24 hours and 30 day after completion of the drilling in Piezometers HMB-1P and HMB-7P ranged from 16 feet to 18.4 feet.

- All excavation operations should be carried out in accordance with OSHA Standards and the City of Houston Standards.

- In general, excavation and backfill for utilities should be designed and constructed in accordance with City of Houston Standard Specification No. 02317. The bedding for sanitary sewer should be in accordance with City of Houston Drawing No. 02317-03.

- The auger pits should be constructed and backfilled per the City of Houston Standard Specifications, Section 02447, "Augering Pipe and Conduit."

- The developed (net) allowable bearing pressures for various structures are presented in Section 5.4 of this report.

1.0 INTRODUCTION

1.1 Project Description

A geotechnical investigation was conducted in connection with the design and construction of FY 2012 Lift Station Renewal and Replacement project in Houston, Texas. The FY 2012 Lift Station Renewal and Replacement project includes the improvements of Northbrook Lift Station, Hardy Temp Lift Station, Hunterwood Lift Station and Harvest Moon Lift Station. The project details are given below:

- Northbrook Lift Station: The improvements include design and construction of a new force main bypass manhole (approximately 10-foot deep) and rehabilitation of an electrical pad.
- Hardy Temp Lift Station : The improvements include design and construction of a new 8-inch gravity sewer connecting from the existing Hardy Temp Lift Station to an existing manholes located across Hardy Toll Road. The gravity sewer will be installed by auger method.
- Hunterwood Lift Station: The improvements include rehabilitation works such as remove and replace pumps and construction of two (2) new bypass manholes (approximately 12 feet and 20-foot deep). The improvements also include removing center wall of the existing wet well and making a larger wet well.
- Harvest Moon Lift Station: The improvements include design and construction of a new wet well approximately 25 feet in diameter and about 48 feet in depth. The project also includes a 30-inch force main (approximately 12 to 28-foot deep) and a gravity sewer (depths ranging from 23 to 28 feet) approximately 3,800 linear feet connecting from Dairy Ashford Lift Station to Harvest Moon Lift Station. The proposed gravity sewer will be constructed by open cut method and proposed force main will be installed by trenchless method.

A project Vicinity Map is shown on Figure 1.

1.2 Geotechnical Investigation Program

The purposes of this study are to evaluate the soil and ground water conditions at each project area and to provide geotechnical recommendations for the proposed improvements at the lift station sites. The scope of this investigation consisted of the following tasks.

- Cored the existing pavement for boring access.
- Drilled and sampled Twelve (12) borings to depths ranging from 15 to 70 feet.
- Converted two (2) borings into a piezometer to monitor the steady groundwater level.
- Performed laboratory tests in accordance with ASTM methods on selected representative soil samples to determine the engineering properties of the soils and to select design soil parameters.
- Performed a review of available fault information to determine the existence of known active faults that may impact this project.
- Performed engineering analyses in accordance with the current City of Houston Infrastructure Design Manual, July 1, 2012 to develop geotechnical recommendations for the design and construction of the proposed improvements at the lift stations.
- Prepared a geotechnical engineering report.
- Prepared a separate soil type report for open excavation.

2.0 FIELD INVESTIGATION

2.1 General

After obtaining the utilities clearance of proposed twelve (12) marked borings in the field, existing concrete pavement was cored at nine (9) boring locations for boring access and borings were drilled to the explored depths utilizing a truck mounted drilling rig. Traffic control devices and personnel were utilized during coring and drilling to maintain safety of drill crew and people driving in the streets. All the drilling and sampling were performed in accordance with appropriate ASTM procedures. **It should be noted that at Harvest Moon Lift Station, the design depths for sanitary gravity sewer and force main, as shown on the 60% submittal drawings, are deeper than the original proposed depths during our proposal stage. The original proposed boring depths at boring locations HMB-2 through HMB-8, do not meet the City of Houston criteria, hence, deepening of borings HMB-2 through HMB-8 will be required.**

2.2 Geotechnical Borings

Subsurface conditions were explored by drilling a total of twelve (12) borings (NBB-1, HTB-1, HTB-2, HWB-1 and HMB-1 through HMB-8) to depths ranging from 15 to 70 feet. The boring locations are presented on Figures 2.1 through 2.4. The survey information (Northing and Easting coordinates and ground surface elevation) of the completed borings were provided to us by ARCADIS. A summary of field exploration is provided on Table 1.

Samples were taken continuously to the terminal depths in all lift station borings and borings which are shallower than 20 feet. Samples were taken continuously to a depth of 20 feet and at 5-foot intervals thereafter in all the other borings. In general, samples of cohesive soils were obtained with a 3-inch thin-walled tube sampler in accordance with ASTM Method D1587 and samples of cohesionless soils were sampled with a 2-inch split-barrel sampler in accordance with ASTM Method D1586. Each sample was removed from the sampler in the field, carefully examined, and then logged by an experienced soils technician. Suitable portions of each sample were sealed and packaged for transportation to Geotest's laboratory. The shear strength of cohesive soil samples was estimated using a pocket penetrometer in the field. The driving resistances for the split-barrel sampler in cohesionless soils, recorded in the field as "blows per foot," are indicated on the boring logs. Borings HMB-1 and HMB-7 were converted each to a piezometer and the rest of the borings were grouted with cement bentonite grout after completion of water level measurements.

Detailed descriptions of the soils encountered in the borings are given on the boring logs NBB-1, HTB-1, HTB-2, HWB-1 and HMB-1 through HMB-8 presented on Figures A-1 through A-12 in Appendix A. A key to "Symbols and Terms used on Boring Logs" is given on Figure A-13 in Appendix A. The depth at which groundwater was encountered during drilling is also noted on the boring logs.

2.3 Piezometer Installation

During the field investigation, two (2) piezometers were installed in the open boreholes of borings HMB-1 and HMB-7. The locations of the piezometers, designated as HMB-1P and HMB-7P, are shown on Plan of Borings Figures 2.1 through 2.6. The piezometer installation reports showing the construction of piezometers, including the water level readings at different dates, are provided on Figures A-14 and A-15 in Appendix A.

The piezometers were abandoned in place after taking final water level readings. The piezometer abandonment reports are presented in Appendix C.

3.0 LABORATORY TESTING

The laboratory testing program was designed to evaluate the pertinent physical properties and shear strength characteristics of the subsurface soils. Classification tests were performed on selected samples to aid in soil classification. All tests were performed in accordance with appropriate ASTM Standards.

Undrained shear strengths of selected cohesive samples were measured by unconsolidated undrained triaxial compression tests (ASTM D2850). Results of the unconsolidated undrained triaxial compression tests are plotted as solid squares on the boring logs. The shear strength of cohesive samples was measured in the field with a calibrated pocket penetrometer and also in the laboratory with a Torvane. The shear strength values obtained from the penetrometer and Torvane are plotted on the boring logs as open circles and triangles, respectively.

Measurements of moisture content (ASTM D2216) and dry unit weight were taken for each unconsolidated undrained triaxial compression test sample. Moisture content measurements were also made on other samples to define the moisture profile at each boring location. Atterberg limits tests (ASTM D4318) were performed on selected cohesive soil samples. Sieve analyses (ASTM D422) and Percent Passing No. 200 Sieve (ASTM D1140) were also performed on selected cohesionless soil and cohesive soil samples to evaluate grain size distribution and physical classification.

The results of most of the laboratory tests are plotted or summarized on the boring logs. The summary of laboratory test results are also presented in a tabular form presented on Figures B-1 through B-12 in Appendix B. The grain size distribution curves are presented on Figure B-13 through B-16 in Appendix B.

4.0 SITE CHARACTERIZATION

4.1 Site Geology

Based on the Houston Sheet, Texas, Geologic Atlas of Texas (Bureau of Economic Geology, University of Texas, 1982) the location of the project alignment lies within the boundaries of the Beaumont Formation's surface exposure. The clays and sands of the Beaumont Formation are over-consolidated as a result of desiccation from frequent rising and lowering of the sea level and the ground water table. Consequently, clays of this formation have moderate to high shear strength and relatively low compressibility. The sands of the Beaumont Formation are typically very fine and often silty. There is evidence in the Houston area of the occurrence of cemented material (sandstone and siltstone) deposits within this formation.

4.2 General Fault Information

A review of information in the Geotest library, relating to known surface and subsurface geologic faults in the general area of the project site, was undertaken. The information consists of U.S. Geological Survey maps, open file reports and information contained in our files relating to geologic faults in the project areas.

Based on the available information, presented below is the fault information for the project areas.

Northbrook Lift Station: No documented faults were noticed near this project area.

Hardy Temp Lift Station: No documented faults were noticed near this project area.

Hunterwood Lift Station: No documented faults were noticed near this project area.

Harvest Moon Lift Station Area: The Long Point Fault crosses the project alignment at Harvest Moon Lane. Hence, a Phase I Geological Fault Study is recommended for the Harvest Moon Lift Station project area. However, it is our understanding that fault studies on Long Point Fault have been performed (by others) for other City of Houston Projects in the general vicinity of Harvest Moon Lift Station area and reports of these studies were made available to the engineer of the record by the City of Houston.

4.3 Existing Paving

The existing pavement as revealed by boring NBB-1 drilled at Northbrook lift station consists of 3 inches of asphalt over 6 inches of sand and shell mix. The existing pavement as revealed by borings HWB-1 drilled at Hunterwood lift station consists of 6 inches of concrete over 6 inches of stabilized sand and shell base. The existing pavement as revealed by borings HMB-1 through HMB-8 drilled at Harvest Moon lift station area revealed 5.5 to 8 inches of concrete over 0 to 8.5 inches of shell and sand base. The borings HTB-1 and HTB-2 at Hardy Temp lift station were drilled in the grass area.

The details are given below:

Existing Pavement					
Lift Station Site	**Boring**	**Asphalt Pavement Thickness (inches)**	**Concrete Pavement Thickness (inches)**	**Base (inches)**	**Total (inches)**
Northbrook	NBB-1	3.0	--	6.0	9.0
Hunterwood	HWB-1	--	6.0	6.0*	12.0
Harvest Moon	HMB-1 (HMB-1P)	--	8.0	8.5	16.5
	HMB-2	--	5.5	--	5.5
	HMB-3	--	7.0	2.0	9.0
	HMB-4	--	6.0	2.0	8.0
	HMB-5	--	6.0	2.0	8.0
	HMB-6	--	7.5	--	7.5
	HMB-7 (HMB-7P)	--	7.5	--	7.5
	HMB-8	--	7.5	--	7.5

Note: * Stabilized sand and shell base.

1) The unstabilized base includes shell, sand, gravel and clay mix.
2) Borings HTB-1 and HTB-2 were drilled in grass area.

4.4 Soil Stratigraphy

Based on the subsurface soils encountered in borings drilled, five (5) boring log profiles were developed and are presented on Figure 3.1 through 3.5 The symbols and abbreviations used on boring log profile is given on Figure 4. To the left of each boring shown on the profile is an indication of the consistency or density of each stratum. More than one consistency for an individual stratum indicates that the consistency varies within the stratum. For cohesive soils, consistency is related to the undrained shear strength of the soil and for cohesionless soils, relative density of soil is measured by blow counts from Standard Penetration Tests. To the right of each boring shown on the profile is the overall classification of the soil contained within each stratum. The classification is based on the ASTM Designation D2487.

The subsurface conditions as revealed by borings drilled at each lift station area are given below:

Northbrook Lift Station (Boring NBB-1). The subsurface soils below the pavement, as revealed by boring NBB-1 and as shown on boring log profile presented on Figure 3.1, consist of fill material to the explored depth of 15 feet. The fill consists of medium stiff to hard fat clay with calcareous and ferrous nodules.

The fat clay fill is of high plasticity with a liquid limit of 56 and a plasticity index of 29. The fines content (percent passing No. 200 sieve) of fat clay is about 86 percent.

Hardy Temp Lift Station (HTB-1 and HTB-2) The subsurface soils below the existing grade, as revealed by borings HTB-1 and HTB-2 and as shown on boring log profile presented on Figure 3.2, consist of cohesive soils underlain by cohesionless soils in boring HTB-1 and cohesive soils with intermittent cohesionless soils in boring HTB-2 to the explored depths of 16 to 20 feet. The cohesive soils consist of medium stiff to very stiff brown, yellowish brown and reddish brown Lean Clay with sand and Sandy Lean Clay. The cohesionless soils consist of medium dense brown and gray Silty Sand.

Fill material consisting of medium stiff to stiff dark gray and gray yellowish brown sandy lean clay w/roots and gravel was encountered below the existing grade to a depth of 4 feet in boring HTB-1.

The sandy lean clay is of medium to high plasticity with liquid limits ranging from 30 to 37 and the plasticity indices ranging from 14 to 21. The fines content (percent passing No. 200 sieve) of Silty Sand ranges from 15 to 18 percent. The fines content of Sandy Lean Clay is about 59 percent.

<u>Hunterwood Lift Station (Boring HWB-1).</u> The subsurface soils below the pavement, as revealed by boring HWB-1 and as shown on boring log profile presented on Figure 3.3, consists of cohesive with intermittent cohesionless soils to the explored depth of 52 feet. The cohesive soils consist medium stiff to very stiff gray Fat Clay, Lean Clay w/sand and Sandy Lean Clay. The cohesionless soils consist of loose to dense brown, gray and brown Silty Sand and Fine Sand w/silt and Sand.

The Fat Clay is of high plasticity with a liquid limit of about 58 and a plasticity index of about 36 to 37. The Lean Clay with sand is of high plasticity with a liquid limit of about 40 and a plasticity index of about 23. The fines content (percent passing No. 200 sieve) of Sand and Fine Sand w/silt ranges from 2 to 10 percent, and the fines content of Silty Sand is about 17 percent. The fines content of Lean Clay with sand is about 74 percent. The fines content of Fat Clay ranges from 86 to 93 percent.

<u>Harvest Moon Lift Station (Boring HMB-1 through HMB-8).</u> The subsurface soils below the existing pavement, as shown on the boring logs HMB-1 through HMB-8 and as shown on boring log profiles presented on Figures 3.4 and 3.5, consist of cohesive soils with intermittent cohesionless soils to the explored depths of 30 to 70 feet. The cohesive soils consists of medium stiff to hard gray, brown and yellowish brown Fat Clay, Fat Clay with sand, Lean Clay with sand, Sandy Lean Clay and Silty Clay. The cohesionless soils consist of loose to very dense brown and gray Silty Sand, Clayey Sand, Silt, Silt with sand and Sandy Silt. **It should be noted that loose silt encountered in boring HMB-4 between the depths of 23 and 28 feet is prone to disturbance and is considered to be unstable soil. Thus, extra precaution should be carried out by using appropriate construction equipments and**

methods to protect the ground and to minimize and prevent any disturbance during the installation of sewer line through this loose silt.

The Fat Clay is of high to very high plasticity with liquid limits ranging from 51 to 76 and plasticity indices ranging from 32 to 48. The Lean Clay with sand, Sandy Lean Clay and Silty Clay are of low to high plasticity with liquid limits ranging from 25 to 46 and plasticity indices ranging from 6 to 27. The fines content (percent passing No. 200 sieve) of Silty Sand ranges from 44 to 46 percent. The fines content of silt and silt with sand ranges from 73 to 91 percent. The fines content of sandy silt ranges from 53 to 69 percent. The fines content of Silty Clay, Lean Clay and Lean Clay w/sand ranges from 76 to 91 percent. The percent fines of Sandy Lean Clay ranges from 56 to 70 percent and the fines content of Fat Clay, Fat Clay with sand ranges from 81 to 100 percent.

4.5 Water Levels

The groundwater level measurements were made in the open boreholes at the time of drilling in all the borings and 24 hours and 30 days water level measurements were made in Piezometers HMB-1P and HMB-7P. The details are given below.

		Range of Groundwater Depth (ft)	
Alignment	**Boring No.**	**During Drilling**	**24hr or more Measured in Piezometer**
Northbrook	NBB-1	--	N/A
Hardy Temp	HTB-1	8.0-10	N/A
	HTB-2	8.9-12	N/A
Hunterwood	HWB-1	19.4-24	N/A

Alignment	**Boring No.**	**Range of Groundwater Depth (ft)**	
		During Drilling	**24hr or more Measured in Piezometer**
Harvest Moon	**HMB-1 (HMB-1P)**	**20.6-32**	**18.5(7-24-13)**
Northbrook	HMB-2	--	N/A
	HMB-3	--	N/A
	HMB-4	19.5-24	N/A
	HMB-5	18.5-24	N/A
	HMB-6	19.8-22	N/A
	HMB-7 (HMB-7P)	**17.0-20**	**16.0 (7-2-13)**
	HMB-8	17.8-24	N/A

Note: * In borings NBB-1, HMB-2 and HMB-3, no ground water was encountered during drilling.

It should be noted that various environmental and man-made factors such as amount of precipitation, could substantially influence groundwater level.

4.6 Environmental Concerns

Based on the borings, no environmental concerns were noticed for the study.

5.0 GEOTECHNICAL RECOMMENDATIONS

5.1 General

A geotechnical investigation was conducted in connection with the design and construction of FY 2012 Lift Station Renewal and Replacement project in Houston, Texas. The FY 2012 Lift Station Renewal and Replacement project includes the improvements of Northbrook Lift Station, Hardy Temp Lift Station, Hunterwood Lift Station and Harvest Moon Lift Station. The project details are given below:

- Northbrook Lift Station: The improvements include design and construction of a new force main bypass manhole (approximately 10-foot deep) and rehabilitation of an electrical pad.
- Hardy Temp Lift Station : The improvements include design and construction of a new 8-inch gravity sewer connecting from the existing Hardy Temp Lift Station to an existing manholes located across Hardy Toll Road. The gravity sewer will be installed by auger method.
- Hunterwood Lift Station: The improvements include rehabilitation works such as remove and replace pumps and construction of two (2) new bypass manholes (approximately 12 feet and 20-foot deep). The improvements also include removing center wall of the existing wet well and making a larger wet well.
- Harvest Moon Lift Station: The improvements include design and construction of a new wet well approximately 25 feet in diameter and about 48 feet in depth. The project also includes a 30-inch force main (approximately 12 to 28-foot deep) and gravity sewer (depths ranging from 23 to 28 feet) approximately 3,800 linear feet connecting from Dairy Ashford Lift Station to Harvest Moon Lift Station. The proposed gravity sewer constructed by open cut method and proposed force main will be installed by trenchless method.

5.2 Open-Cut Excavation

5.2.1 Geotechnical Parameters. Based on the soil conditions revealed by the borings, geotechnical parameters were developed for the design of the proposed lift stations and open cut excavation for gravity sewer and auger pits for gravity sewer and force main. The geotechnical design parameters are provided in Table 2. For design, the groundwater level should be assumed to exist at the ground surface, since this condition may exist after a heavy rain or flooding.

5.2.2 Excavation Stability. The open excavation for auger pits and open trench may be shored, laid back to a stable slope or some other equivalent means used to provide safety for workers and adjacent structures. The excavating and trenching operations should be in accordance with OSHA Standards, OSHA 2207, Subpart P, latest revision and the City of Houston requirements.

- Excavation Shallower Than 5 Feet – Excavations that are less than 5 feet (critical height) deep should be appropriately protected when any indication of hazardous ground movement is anticipated.

- Excavation Deeper Than 5 Feet - Excavations that are deeper than 5 feet should be sloped, shored, sheeted, braced or laid back to a stable slope or supported by some other equivalent means or protection such that workers are not exposed to moving ground or cave-ins. The slopes and shoring should be in accordance with the trench safety requirements per OSHA Standards.

  In view of relatively weak soils (medium stiff fat clay and sandy lean clay) encountered between the depths of 12 and 26 feet in boring HWB-1, a soil retention system is recommended for Hunterwood Lift Station location. The retention system should remain in place until backfilling is within 5 feet of the ground surface. Based on the soil conditions and proposed excavation depth of about 20 feet for the wet well, the following alternatives can be considered for soil retention.

1. Temporary sheet piles
2. H-piles with wooden lagging

Sheet piles may be driven or vibrated in place. We understand that due to the proximity of the existing structures, such as existing lift station, driving/vibrating sheet piles will have some effect on existing structures and this option has to be reevaluated. It is our opinion that the H-piles with wooden lagging may be a feasible option for this project.

The following items provide design criteria for excavation stability.

(i) OSHA's Soil Type. Based on the soil conditions revealed by the borings and the assumed groundwater level at surface, OSHA's soil type "C" should be used for the determination of allowable maximum slope and/or the design of a shoring system. For shoring deeper than 20 feet, an engineering evaluation is required.

(ii) Excavation Support Earth Pressure. Based on the subsurface conditions indicated by this investigation and laboratory testing results, the excavation support earth pressure diagrams were developed and are presented on Figures 5.1 thru 5.3. These pressure diagrams can be used for the design of temporary excavation bracing. For a trench box, a lateral earth pressure resulting from an equivalent fluid with a unit weight of 94 pcf is recommended. The above value of equivalent fluid pressure is based upon an assumption that the groundwater level is near the ground surface, since these conditions may exist after a heavy rain or flooding. Effect of surcharge loads at the ground surface should be added to the computed lateral earth pressure. A surcharge load, q, will typically result in a lateral load equal to 0.5 q.

If H piles with wooden lagging are planned at Hunterwood Lift Station, the piles should penetrate at least 10 feet below the bottom of excavation with a bracing at about 6 feet from the ground surface.

(iii) Bottom Stability. In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable under certain conditions. This condition is governed by the shear strength of the soils and by the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cuts in cohesive soils, as encountered for the anticipated excavation depths of about 10 to 28 feet, the stability of the bottom can be evaluated in accordance with the procedure outlined on Figure 6. However, at borings HTB-1, HTB-2, HMB-1, HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8 where cohesionless (such as silty sand, fine sand with silt, silt w/sand and silt) were encountered at the invert or within 3 feet from bottom of invert, dewatering will be required to prevent bottom blowup.

5.2.3 Groundwater Control. Excavations for the proposed sanitary sewer and force main may encounter groundwater seepage to varying degrees depending upon groundwater conditions at the time of construction and the location and depth of excavation. In cohesive soils, as encountered in the borings for the excavation depths of 10 to 28 feet, groundwater may be managed by collection in trench bottom sumps for pumped disposal. However, at borings HTB-1, HTB-2, HMB-1, HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8 where cohesionless (such as silty sand, fine sand with silt, silt w/sand and silt) were encountered at the invert or within 3 feet from bottom of invert, dewatering such as vacuum well points (for excavation depth up to 15 feet) and deep wells with submersible pumps (for excavation depth greater than 15 feet) may be required to lower the ground water level at least 5 feet below the bottom of excavation.

It is recommended that the groundwater conditions be verified at the time of construction and that groundwater control be performed in general accordance with City of Houston Standard Specifications, Section 01578.

5.2.4 Live Loads on Pipe Due to Traffic. Loads on pipe due to traffic should be considered. A graph providing calculated vertical stress on pipe due to traffic loads is given on Figure 7.

5.2.5 Auger Pit Backfill. The excavated auger pit should be backfilled per the City of Houston Standard Specification Section 02447, "Augering Pipe and Conduit," Subsection 3.04.

5.3 Trenchless Installation

It is understood that the proposed gravity sewer at Hardy Temp lift station site and gravity sewer and 30-inch sanitary force main at Harvest Moon Lift station will be installed by auger method.

5.3.1 Geotechnical Parameters. Based on the soil conditions revealed by soil borings, laboratory test data, geotechnical design parameters were developed for cohesive soils and cohesionless soils and are provided in Tables 3.1 and 3.2. The cohesive soils include fat clay, lean clay, lean clay w/sand and sandy lean clay. The cohesionless soils include silty sand, sandy silt, silt w/sand and silt. For design conditions, the groundwater levels should be assumed to exist at the ground surface.

5.3.2 Earth Pressure on Pipe and Casing Augering. The earth pressures on pipe and casing augering should be determined from Figure 8. Equations to calculate the auger casing loads are also shown on Figure 8.

5.3.3 Carrier Pipe Design Parameters. Carrier pipe must be sufficiently strong to withstand anticipated long-term ground loads and must not be subjected to deterioration by substance either in ground or in the auger casing. The carrier pipe design should include consideration of not only the loads applied to the pipe but also factors other than soil loading. These factors could include minimum structural code requirements, loading from pipe jacking operations and other construction loads. The drained geotechnical design parameters given in Tables 3.1 and 3.2 should be used to analyze the soil structure intersection of the carrier pipe.

5.3.4 Influence of Augering on Adjacent Structures. Surface and near-surface structures near the pipe and casing augering consist primarily of city streets, street crossings, public and private utilities.

Ground movement, in terms of loss of ground or ground lost, is commonly associated with soft ground augering. If such ground movement is excessive, it may cause damage to the structures, roads and services located above the auger casing. While ground movement cannot be eliminated, it can be controlled within certain limits by the use of proper construction techniques and good quality workmanship. These include, but are not limited to, prevention of excessive ground loss during augering with the use of grouting and filling the annular space between the pipe or casing and the surrounding soil and prevention of undue loss of fines through dewatering.

The selection and execution of augering methods that are best suited to anticipated ground conditions along the proposed auger casing are, in fact, the contractor's primary contribution to successful completion of the proposed auger casing. On review of the boring logs, the ground conditions for augering (excavation face) will be primarily through fat clay, lean clay, and sandy lean clay layers, except at borings HTB-1, HTB-2, HMB-1, HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8 where excavation face will be in cohesive interface with cohesionless soils or in cohesionless soils. Most of the cohesive soils are medium stiff to very stiff in consistency and ground in these soils may be expected to behave as squeezing to ravelling ground near the invert. The cohesionless soils (silty sand, sandy silt and silt) are loose to medium dense and the ground at these locations may be expected to behave raveling to running ground near the invert depths. Hence, extra precautions will be required by using the appropriate techniques at these locations, especially near boring HMB-4 where loose silt was encountered between the depths of 23 feet and 28 feet, during the trenchless installation to prevent any excessive ground loss due to the disturbance and removal of the cohesionless soils. Close monitoring of ground movement should be carried out during the trenchless installation.

The extra precautions may include:

- Shorten duration between auger excavation and pushing of casing/pipe as minimum as possible.
- Alternatively use steel pipe in these areas.
- If any excessive ground loss is observed during closed monitoring, grouting will be required to fill any voids.

At locations near borings HTB-1, HTB-2, HMB-1, HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8 , the ground conditions for trenchless operation (excavation face) will be through cohesive soil interface with cohesionless soils or in cohesionless soils. In such conditions, dewatering will be necessary.

The proposed auger casing is parallel with or cross beneath utility lines. The largest potential problems from utilities may result from:

- Leaking water pipes
- Gas pipe breakage leading to a potential explosion
- Breakage of storm or sanitary sewers

In general, it is the contractor's responsibility to investigate these and other possible third party interactions along the proposed gravity sewer alignments and to accommodate all of these interactions with the use of good construction methods.

5.4 Structures

5.4.1 Description. The structures associated with this project will be an electrical pad and manhole (approximately 10-foot deep) at Northbrook lift station, manholes (approximately 12 to 20-

foot deep) at Hunterwood lift station and manholes (approximately 23.5 to 28-foot deep) and new wet well (approximately 48-foot deep) at Harvest Moon lift station.

5.4.2 Foundation Conditions. Based on the soil conditions revealed by the borings, the mat foundation supporting the electrical pad and manhole at Northbrook lift station will be placed at 2 feet and 10 feet, will be in medium stiff to very stiff fat clay fill material. The mat foundation for supporting the manholes at Hunterwood lift station, placed at a depth of 12 to 20 feet, will be in medium stiff sandy lean clay. The foundation for supporting wet well at Harvest Moon lift station, placed at a depth of 48 feet, will be in hard fat clay and the manholes placed at a depths of 24 to 28 feet will be either in stiff to very stiff sandy lean clay and clay or medium dense silty sand.

5.4.3 Foundation Design Recommendations. The following items provide recommendations and design criteria for construction of the mat foundations for the electrical pad at Northbrook lift station and wet wells at Hunterwood and Harvest Moon lift stations and manholes at Harvest Moon Lift Station.

- Allowable Bearing Pressures

The allowable bearing pressures for the all the proposed structures are given below:

Lift Station	**Structure Type**	**Borings**	**Range of Depth (ft)**	**Net Allowable Bearing Pressure (psf)**
Northbrook Lift Station	Electrical Pad Force Main Manhole	NBB-1	2 10	1,670 3,000
Hunterwood Lift Station	6' Diameter Manhole 6' Diameter Manhole	HWB-1	12 20	1,500 1,500
Harvest Moon Lift Station	Wet Well	HMB-1	48	6,000
	Manhole No.1 (Sta. 2+80)	HMB-8	23.5	2,500
	Manhole No.2 (Sta. 8+00)	HMB-7	24.0	2,000
	Manhole No.3 (Sta. 12+20) Manhole No.4 (Sta. 14+25) Manhole No.5 (Sta. 15+05) Manhole No.6 (Sta. 16+22)	HMB-6	27-28	5,000

Lift Station	**Structure Type**	**Borings**	**Range of Depth (ft)**	**Net Allowable Bearing Pressure (psf)**
Harvest Moon Lift Station	Manhole No.7 (Sta. 17+80 Manhole No.8 (Sta. 18+25)	HMB-5	27-28	3,000
	Manhole No.9 (Sta. 23+50) Manhole No.10 (Sta. 27+00)	HMB-4	28	3,000
	Manhole No.11 (Sta. 31+10)	HMB-3	28	5,000
	Manhole No.12 (Sta. 33+15) Manhole No.13 (Sta. 34+70) Manhole No.14 (Sta. 37+10)	HMB-2	28	2,000
	Manhole No.15, 16, 17, 18 (Sta. 42+37)	HMB-1	27	1,800

These allowable bearing pressures include a safety factor of at least 2.0. The above recommendations assume that the final bearing surfaces consist of undisturbed natural soils and that underlying semi-transmissive zones are properly pressure-relieved and stable undisturbed bearing surfaces are attained.

At Northbrook Lift Station, as revealed by boring NBB-1, the surficial high plasticity clay fill possesses a high potential for shrinking and swelling and is considered unsuitable for slab-on-grade construction without any proper treatments. Hence, it is recommended that the high plasticity clay fill be excavated and removed to a depth of at least 24 inches in the slab area and extended at least 5 feet beyond the slab area and replaced it with the compacted structural fill.

At Hunterwood Lift Station area, the relatively weak soils were encountered at the bottom of the proposed manholes, thus, foundation improvements such as cement stabilized sand or crushed stone support for the manholes will be required.

- <u>Bottom Stability.</u> In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable under certain conditions. This condition is governed by the shear strength of the soils and by the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cuts in cohesive soils, as encountered for the excavation depths of 10 to 28 feet, the stability of the bottom can be evaluated in accordance with the procedure outlined on Figure 6. However, at borings HTB-1, HTB-2, HMB-1, HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8 where cohesionless (such as silty sand, fine sand with silt, silt w/sand and silt) were encountered at the invert or within 3 feet from bottom of invert, dewatering will be required to prevent bottom blowup.

- <u>Lateral Earth Pressure.</u> The pressure diagram presented on Figures 5.1 through 5.3 can be used for the design of braced excavation. The lateral earth pressure diagrams presented on Figures 9.1 through 9.3 are applicable for the design of the permanent walls.

- <u>Hydrostatic Uplift Resistance.</u> Structures extending below the groundwater level should be designed to resist uplift pressure resulting from excess piezometric head. Design uplift pressures should be computed based on the assumption that the water table is at ground surface. To resist the hydrostatic uplift at the bottom of the structure, one of the following sources of resistance can be utilized in each of the designs.

    a. Dead weight of structure,
    b. Weight of soil above base extensions plus weight of structure, or
    c. Soil-wall friction plus dead weight of structure.

  The uplift force and resistance to uplift should be computed as detailed on Figure 10. In determining the configuration and dimensions of the structure using one of the approaches presented on Figure 10, the following factors of safety are recommended.

a. Dead weight of concrete structure, $S_{f1} = 1.10$,

b. Weight of soil (backfill) above base extension, $S_{f2} = 1.5$, and

c. Soil-wall friction, $S_{f3} = 3.0$.

Friction resistance should be discounted for the upper 5 feet, since this zone is affected by seasonal moisture changes.

5.4.4 Protection of Below Grade Structures. The design of the proper means for protection of below grade structures will depend upon the potential of the aggressivity or corrosivity of soil and groundwater properties. The aggressivity testing was not within the scope of this study. The design of the protection of below grade structures is beyond the scope of services for this study.

5.4.5 Groundwater Control During Construction. The ground water control should be per guidelines as outlined in Section 5.2.3 of this report.

5.4.6 Structure Backfill. Excavations for the proposed structures should be backfilled in accordance with the City of Houston Standard Specifications, Section 02316, “Excavation and Backfill for Structures.”

6.0 CONSTRUCTION CONSIDERATIONS

It is understood that the preliminary plans call for the lift station at the Harvest Moon Lift Station to be constructed as a sunken caisson. The caisson procedure eliminates the need for temporary retention system. Caisson can, however, experience problems with alignment and termination at the proper design depth. Once in place, excavation of soils within the interior of caisson will require maintaining the stability of the excavation bottom. Stability considerations of the excavation bottom are similar to those described in Section 5.4.3 of this report. Based on the cohesive soils, water level encountered at the lift station site, the caisson may be constructed by wet method as described below.

<u>Excavation of Lift Station without Dewatering (Wet Method).</u> In wet method, the differential hydrostatic pressure from the groundwater level within the retained soils is balanced by maintaining a sufficient head of water or slurry within the interior of the caisson during excavation. At all times during construction by the wet method, the level of water or slurry within the caisson should be maintained above external water level. Once excavation is complete, a seal slab of appropriate thickness should be constructed by placing concrete through a tremie. Once the concrete has set and sufficient weight has been added to overcome buoyant forces, the water or slurry within the caisson can be pumped out and the structural slab constructed.

<u>Excavation of Lift Station after Dewatering (Dry Method).</u> Instability of the excavation bottom can be attenuated by dewatering the transmissive silty sand. An appropriate dewatering system should be installed outside the perimeter of the caisson area prior to sinking. The dewatering system should maintain the groundwater level at least 5 feet below the proposed bottom of the lift station throughout the period of the excavation and construction of the structural slab.

Of primary concern during dewatering is the loss of fines from the stratum of the dewatering system. To reduce the loss of fines an appropriate filtering system should be incorporated in the design of the well screens of the dewatering system.

7.0 PROVISIONS

The description of subsurface conditions and the design information contained in this report are based on the test borings made at the time of drilling at specific locations. Some variation in soil conditions may however, occur between test borings. Should any subsurface conditions other than those described in our boring logs be encountered, Geotest should be immediately notified so that further investigation and supplemental recommendations can be provided.

The depth of the groundwater level may vary with changes in environmental conditions such as frequency and magnitude of rainfall. The stratification lines on the log of borings represent the approximate boundaries between soil types. Transitions between soil types may be more gradual than depicted.

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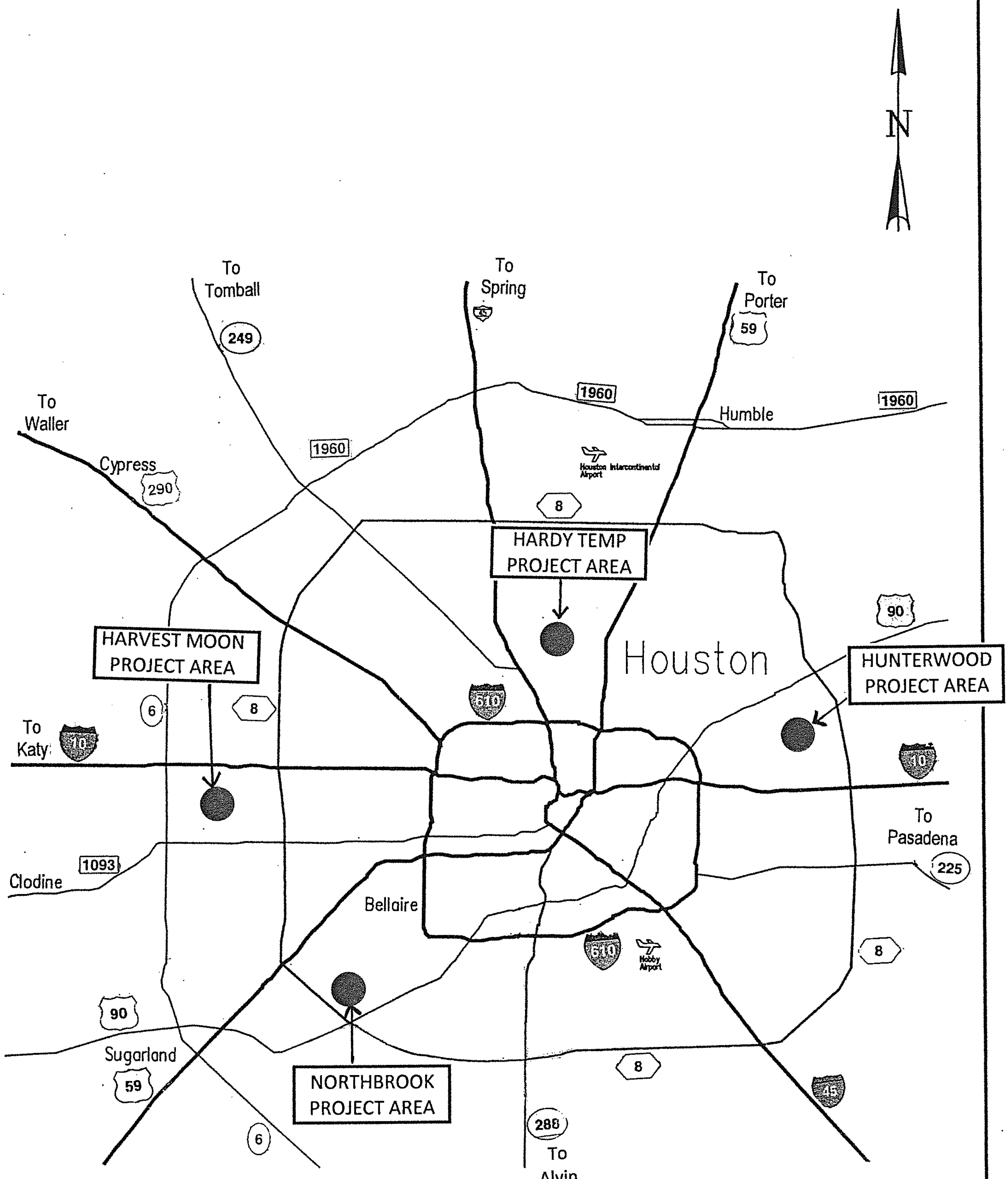
ILLUSTRATIONS

Job No. 1140194901

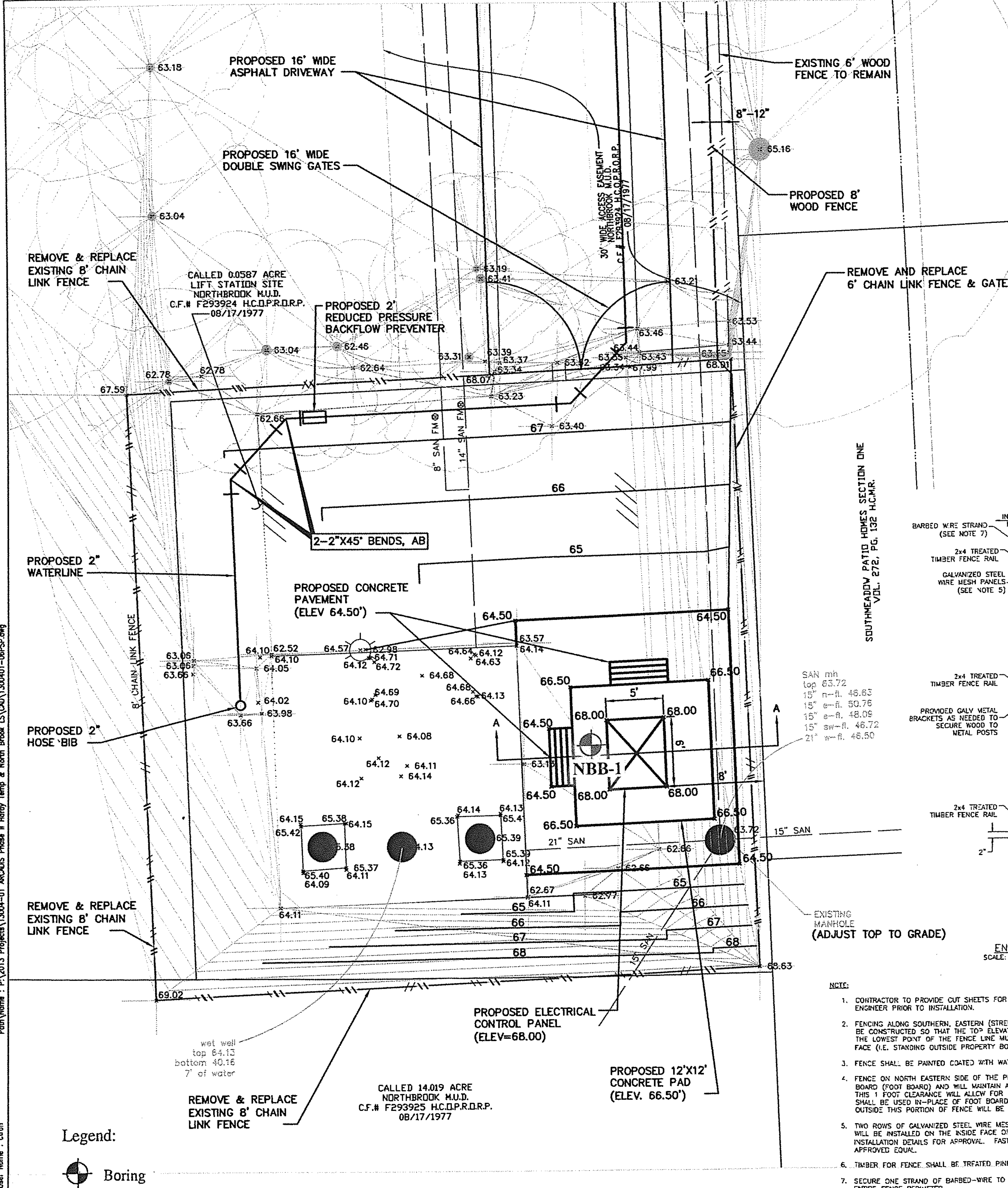


VICINITY MAP
(NOT TO SCALE)

Geotest Engineering, Inc.

FIGURE 1

Job No. : 1140194901



NORTH BROOK LIFT STATION REFERENCE BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 040840 IS A HCFCD BRASS DISK STAMPED D140 0840D ON BRIDGE AT S. GESSNER ROAD N-BOUND AND D140-D4-00 LOCATED ON DOWNSTREAM, EAST CURB UNDER GUARDRAIL, AT STREAM CENTERLINE. IN KEYMAP 570F.

ELEV.=62.19 FEET NAVD 1988, 2001 ADJUSTED.

NORTH BROOK LIFT STATION TEMPORARY BENCHMARK:

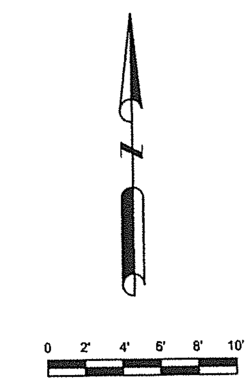
T.B.M. #103
SET MAG NAIL ON ASPHALT LOCATED BY THE GATE INSIDE OF THE SUBJECT LIFT STATION PROPERTY.
ELEV.=63.66'

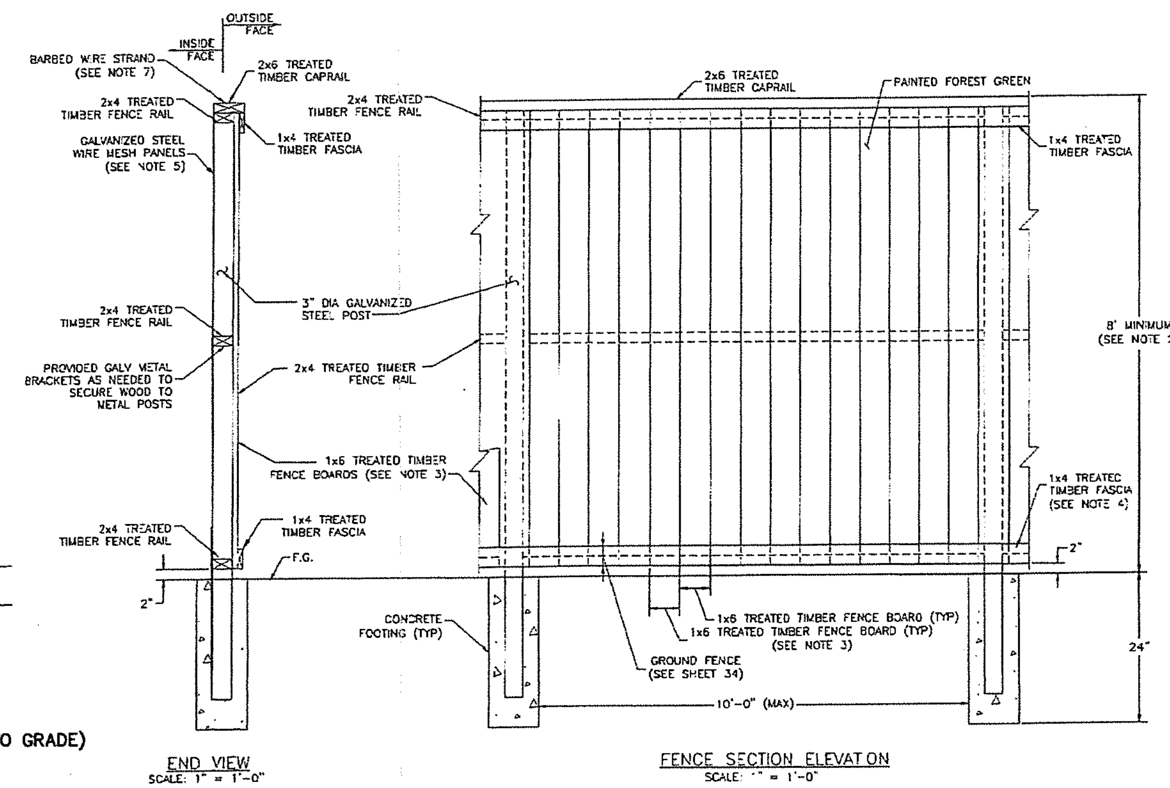
EXISTING UTILITY NOTE:

EXISTING UNDERGROUND UTILITY INFORMATION (TYPE, SIZE & OWNERSHIP) ARE SHOWN APPROXIMATELY BASED ON THE AVAILABLE RECORD DRAWINGS AND FIELD VERIFICATION (WHERE VISIBLE) WITHOUT PROBING AND EXCAVATION. NO WARRANTY IS MADE AS TO THE ACCURACY OR COMPLETENESS OF UTILITY LOCATION SHOWN ON THE DRAWING. CAUTION SHOULD BE EXERCISED WHEN EXCAVATING OR BORE AND JACKING IN THE VICINITY OF UNDERGROUND UTILITIES. OWNERS OF THE UTILITIES SHOULD BE NOTIFIED PRIOR SUCH ACTIVITIES. CALL UTILITY COORDINATING COMMITTEE AT 713-223-4567, AT LEAST 48 HOURS PRIOR TO EXCAVATING IN THE STREET RIGHT-OF-WAY.

NOTES:

1. THIS SURVEY WAS PREPARED WITHOUT THE BENEFIT OF A TITLE COMMITMENT; THEREFORE, ALL EASEMENTS, BUILDING LINES OR ANY ENCUMBRANCES MAY NOT BEEN SHOWN.





END VIEW
SCALE: 1" = 1'-0"

FENCE SECTION ELEVATION
SCALE: 1" = 1'-0"

NOTE: SOME HIDDEN LINES OMITTED FOR CLARITY.

NOTE:

1. CONTRACTOR TO PROVIDE CUT SHEETS FOR FENCE INSTALLATION DETAILS FOR APPROVAL BY ENGINEER PRIOR TO INSTALLATION.
2. FENCING ALONG SOUTHERN, EASTERN (STREET SIDE), AND NORTHEASTERN BOUNDARY SHALL BE CONSTRUCTED SO THAT THE TOP ELEVATION OF THE FENCE IS THE SAME AND LEVEL. THE LOWEST POINT OF THE FENCE LINE MUST STAND A MINIMUM OF 8 FEET TALL ON OUTSIDE FACE (I.E. STANDING OUTSIDE PROPERTY BOUNDARY).
3. FENCE SHALL BE PAINTED COATED WITH WATER PROOF STAINING (LIGHT BROWN)
4. FENCE ON NORTH EASTERN SIDE OF THE PROPERTY SHALL NOT HAVE A BASE BOARD (FOOT BOARD) AND WILL MAINTAIN A 1 FOOT CLEARANCE ABOVE THE FINAL GRADE. THIS 1 FOOT CLEARANCE WILL ALLOW FOR DRAINAGE OF STORM WATER. VINYL LATTICE BOARD SHALL BE USED IN-PLACE OF FOOT BOARD ALONG THIS SECTION OF THE FENCE. THE AREA OUTSIDE THIS PORTION OF FENCE WILL BE REPLANTED TO CONCEAL THE GAP.
5. TWO ROWS OF GALVANIZED STEEL WIRE MESH PANELS 48" TALL PANELS WILL BE INSTALLED ON THE INSIDE FACE OF FENCE TO ADD SECURITY. CONTRACTOR TO PROVIDE INSTALLATION DETAILS FOR APPROVAL. FASTEN MESH WITH METALS AND/OR BRACKETS OR APPROVED EQUAL.
6. TIMBER FOR FENCE SHALL BE TREATED PINE.
7. SECURE ONE STRAND OF BARBED-WIRE TO TOP RAILING (INCLUDING GATE) ALONG ENTIRE FENCE PERIMETER

FIGURE 2.1

60% SUBMITTAL

NO	DATE	REVISIONS	APP

PRIVATE UTILITY LINES SHOWN

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Engineers, Planners & Managers
6161 Savoy, Suite 550
Houston, Texas 77036
713.541.3530 • www.gundacorp.com
TBPE Registration Number: F-3531

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2929 Briarpark Dr
Suite 300
Houston, TX 77042
Tel: 713-953-4800 Fax: 713-977-4620
www.arcadis-us.com
Texas Registered Engineering Firm F-533

DATE: JULY 2013
JOB NO. TX000942.0002

DESIGNED BY: DFR
DRAWN BY: WCW

PRELIMINARY REVIEW ONLY
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KRISTEN JILL HENNINGS, P.E.
P.E. SERIAL No. 90169
DATE: 08/13/13

SURVEYED BY: KUO & ASSOC.
FB NO.: P-XXXX

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION RENEWAL / REPLACEMENT PROJECT

NORTHBROOK LIFT STATION PROPOSED SITE PLAN

C6

WBS#: R-000267-0111-4

DRAWING SCALE:
1"=5'

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 121 OF 190

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Date\Time : Wed, 14 Aug 2013 - 9:24am
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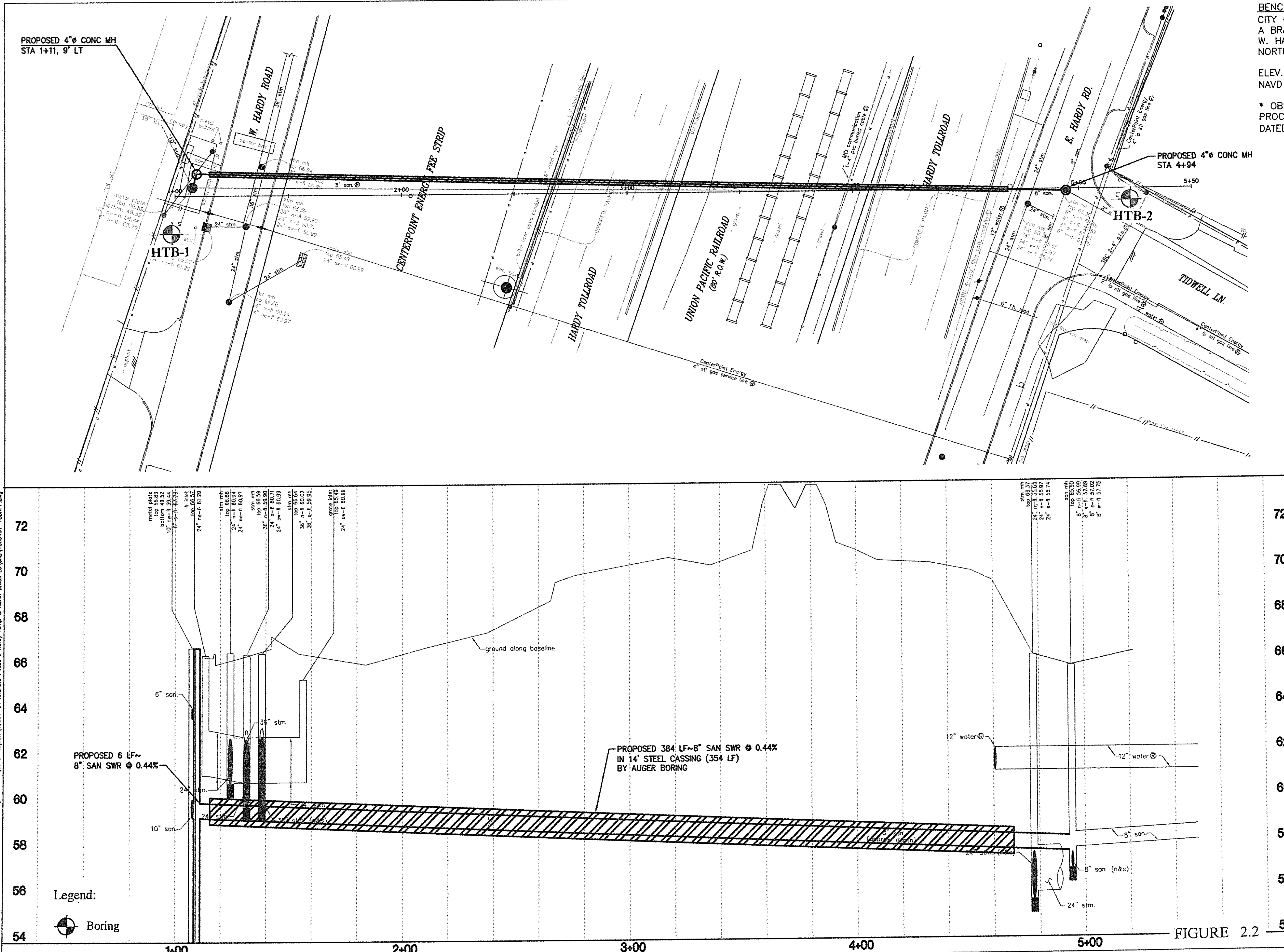
Job No. : 1140194901



BENCHMARK:
CITY OF HOUSTON MONUMENT 5461-0306, A BRASS DISK IN CONCRETE, LOCATED ON W. HARDY ST APPROXIMATELY 0.15 MILES NORTH OF TIDWELL ROAD.

ELEV. 66.401 Feet
NAVD 1988 (CORS96)*

* OBSERVED BY GPS SURVEYING AND PROCESSED IN REFERENCE TO THE CORS DATED MAY 28, 2013 & GEOID '12A.

60% SUBMITTAL

PRIVATE UTILITY LINES SHOWN

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AT&T TEXAS/SWBT UTILITY LINES SHOWN — DATE:

CENTERPOINT ENERGY/GAS FACILITIES — DATE:

GUNDA CORPORATION
Engineers, Planners & Managers

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Houston, TX 77042
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www.arcadis-us.com
Texas Registered Engineering Firm F-533

DATE: JULY 2013
JOB NO. TXD00942.0002
DESIGNED BY: DFR
DRAWN BY: WCW

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P.E. SERIAL No. 90169
DATE: 08/13/13

SURVEYED BY: KUO & ASSOC.
FB NO.: P-5698

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION RENEWAL / REPLACEMENT PROJECT

HARDY TEMP ELIMINATION PLAN AND PROFILE

C5

WBS#: R-000267-0111-4

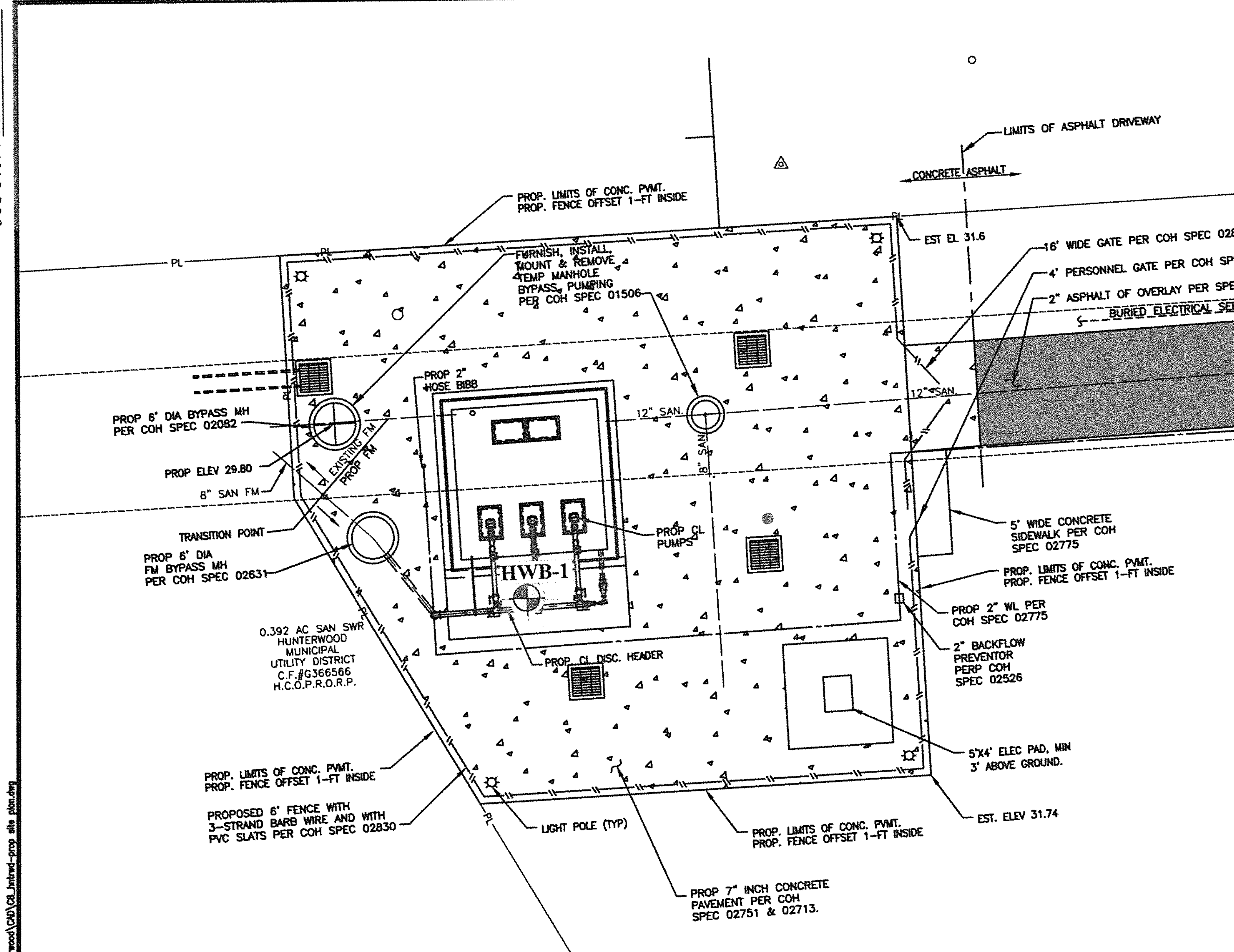
DRAWING SCALE: 1" = 40'

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 153 OF 190

FIGURE 2.2

Job No. : 1140194901



HUNTERWOOD LIFT STATION REFERENCE BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 150250 IS A BRASS DISK STAMPED 150250 ON BRIDGE AT INTERSECTION OF P109-00-00 AND GRAVEL ROAD, EAST OF SOUTH LAKE HOUSTON PARKWAY AND NORTH OF BARNESWORTH DRIVE LOCATED EAST ALONG THE POWER EASEMENT GRAVEL ROAD ON EAST ABUTMENT OF BRIDGE. IN KEYMAP 456V.

ELEV.=33.02 FEET NAVD 1988, 2001 ADJUSTED.

HUNTERWOOD LIFT STATION TEMPORARY BENCHMARK:

T.B.M. K
SET BOX CUT ON POWER POLE LOCATED IN EASEMENT IN FRONT OF THE SUBJECT LIFT STATION.

ELEV.=34.99'

EXISTING UTILITY NOTE:

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NO	DATE	REVISIONS	APP

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Texas Registered Engineering Firm F-533

DATE: AUGUST 2013
JOB NO. TX000967.0004
DESIGNED BY: DR
DRAWN BY: WW

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SURVEYED BY: KUO AND ASSOCIATES FB NO.: P-5698

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION RENEWAL / REPLACEMENT PROJECT

HUNTERWOOD LIFTSTATION PROPOSED SITE PLAN

C8

WBS#: R-000267-0111

DRAWING SCALE: 1"=10'

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 79 OF 190

10 5 0 10 20
GRAPHIC SCALE IN FEET

Legend:

Boring

FIGURE 2.3

Acad Version : R18.1s (LMS Tech)
User Name : emarks
Date\Time : Thu, 15 Aug 2013 - 7:03pm
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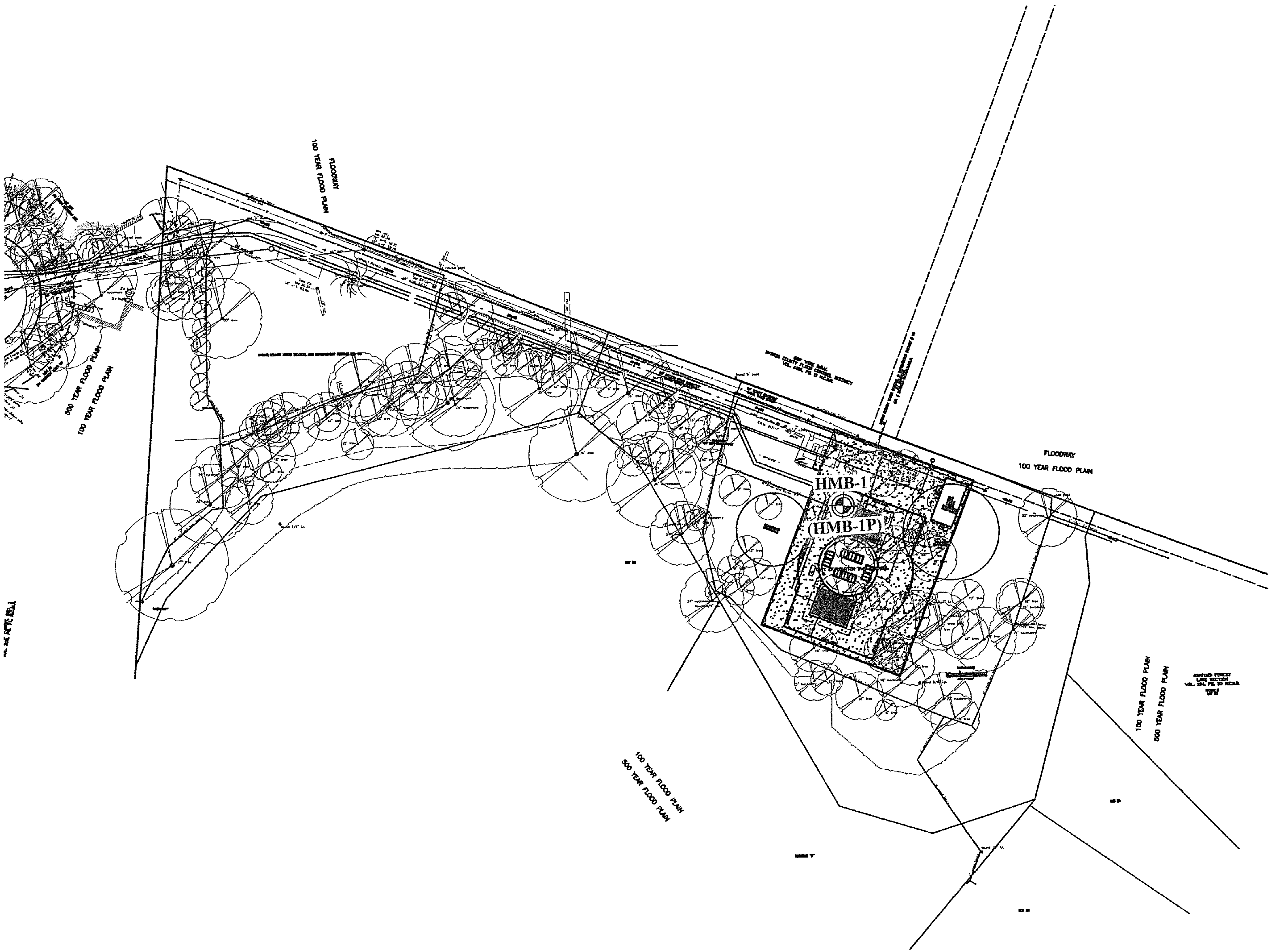
ORIGINAL SCALE IN INCHES 0 1 2 3 FOR REDUCED PLANS

Job No. : 1140194901



60%
SUBMITTAL

NO	DATE	REVISIONS	APP

PRIVATE UTILITY LINES SHOWN

DATE:

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(APPROVED ONLY FOR CROSSING UNDERGROUND DUCTLINES, UNLESS OTHERWISE NOTED.) VALID AT TIME OF REVIEW ONLY.

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APPROVED AT&T TEXAS/SWBT FOR UNDERGROUND CONDUIT FACILITIES ONLY SIGNATURE VALID FOR ONE YEAR.

DATE:

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Texas Registered Engineering Firm F-533

DATE: AUGUST 2013
JOB NO. TX000967.0004

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DRAWN BY: WW

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TEXAS P.E. No. 85559

SURVEYED BY: KUO AND ASSOCIATES
FB NO.: P-5696

AUGUST 2013
DATE

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION
RENEWAL / REPLACEMENT
PROJECT

HAR□EST MOON L□S□
PROPOSED O□ERALL
SITE PLAN

C10

WBS#: R-000267-0111

DRAWING SCALE:

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 18 OF 190

Date\Time : Wed, 14 Aug 2013 - 6:24pm
Path\Name : I:\ACAD\PROJ\000267.0111_COH\002 Detail Design\Harvest Moon\CAD\C10_HMLSR-Prop Site Plan Overall.dwg

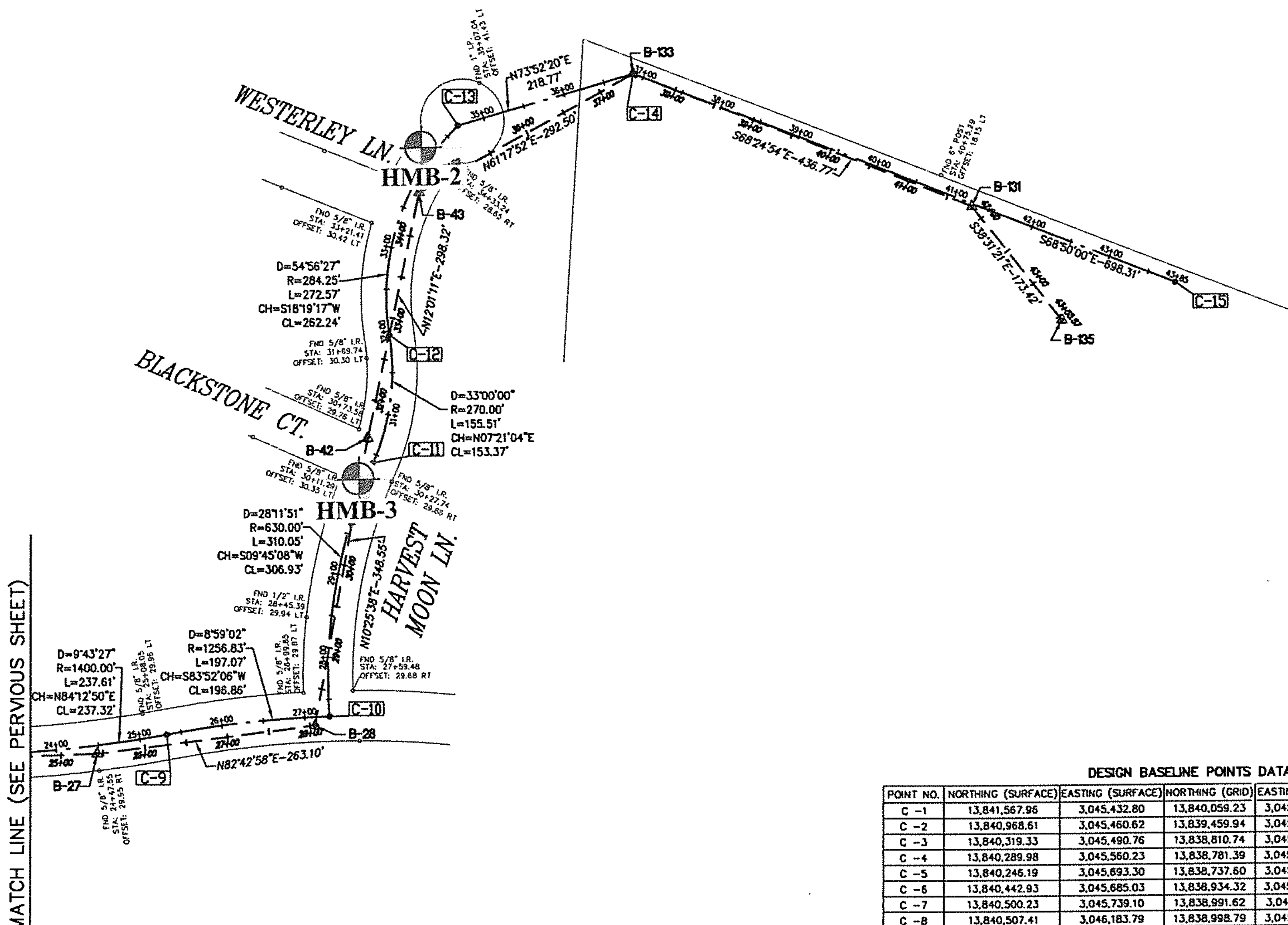
Acad Version : R18.1s (LMS Tech)
User Name : emarks

Legend:

- Boring
- Boring with Piezometer

FIGURE 2.4

Job No. : 1140194901



SCALE: 1" = 100'-0"

BENCHMARK:

CITY OF HOUSTON MONUMENT ____/____ AN HCFCD BRASS DISC (BEARING HARRIS COUNTY FLOODPLAIN REFERENCE MARK NUMBER 210180) ON BRIDGE AT S. DAIRY ASHFORD RD AND BUFFALO BAYOU LOCATED ON EAST SIDEWALK OF NORTHBOUND BRIDGE, AT STREAM CENTERLINE.

ELEV. 76.69 Feet NAVD 1988 (CORS96)*

* OBSERVED BY GPS SURVEYING AND PROCESSED IN REFERENCE TO THE CORS DATED APRIL 30, 2013 & GEOID '12A.

NOTE:

ALL BEARINGS AND DISTANCES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83 (CORS96). ALL DISTANCES ARE IN SURFACE.

THE COORDINATES SHOWN HEREON ARE TEXAS SOUTH CENTRAL ZONE NO. 4204 STATE PLANE GRID COORDINATES (NAD83) AND MAY BE BROUGHT TO SURFACE BY DIVIDING BY THE COMBINED SCALE FACTOR 0.999891.

LEGEND:

B-XX SURVEY CONTROL POINT NUMBER
C-X DESIGN BASELINE POINT NUMBER
SURVEY CONTROL POINT
DESIGN BASELINE POINT
CITY OF HOUSTON MONUMENT
D. BL: DESIGN BASELINE
S. BL: SURVEY BASELINE

DESIGN BASELINE POINTS DATA

POINT NO.	NORTHING (SURFACE)	EASTING (SURFACE)	NORTHING (GRID)	EASTING (GRID)	D. BL STA.	DESCRIPTION
C -1	13,841,567.96	3,045,432.80	13,840,059.23	3,045,100.85	1+00	WILL BE SET AT 90%
C -2	13,840,968.61	3,045,460.62	13,839,459.94	3,045,128.67	7+00	
C -3	13,840,319.33	3,045,490.76	13,838,810.74	3,045,158.80	13+49.97	
C -4	13,840,289.98	3,045,560.23	13,838,781.39	3,045,228.27	14+25.39	
C -5	13,840,246.19	3,045,693.30	13,838,737.60	3,045,361.32	15+65.64	
C -6	13,840,442.93	3,045,685.03	13,838,934.32	3,045,353.05	17+62.55	
C -7	13,840,500.23	3,045,739.10	13,838,991.62	3,045,407.11	18+50.37	
C -8	13,840,507.41	3,046,183.79	13,838,998.79	3,045,851.75	22+95.12	
C -9	13,840,531.33	3,046,419.90	13,839,022.71	3,046,087.84	25+32.72	
C -10	13,840,552.36	3,046,615.64	13,839,043.74	3,046,283.56	27+29.79	
C -11	13,840,854.85	3,046,667.63	13,839,346.20	3,046,335.54	30+39.84	
C -12	13,841,006.96	3,046,687.26	13,839,498.29	3,046,355.17	31+95.35	
C -13	13,841,255.91	3,046,769.69	13,839,747.21	3,046,437.59	34+67.91	
C -14	13,841,316.68	3,046,979.86	13,839,807.98	3,046,647.73	36+86.69	
C -15	13,841,064.53	3,047,631.05	13,839,555.85	3,047,298.86	43+85	

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Suite 300
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Texas Registered Engineering Firm F-533

DATE: JULY 2013
JOB NO. TX000967.0006

DESIGNED BY: SC
DRAWN BY: CH

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Consulting Engineers & Surveyors
10700 Richmond Ave., Suite 113, Houston, Texas 77042
Tel: 713-975-8769, Fax: 713-975-0920, www.kuoassociates.com
Texas Firm Registration No. F-4578

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SHAHEEN CHOWDHURY, R.P.L.S.
TEXAS REG. NO.: 5858
DATE: JULY 2013

SURVEYED BY: KUO & ASSOC.
FB NO.: P-XXXX

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION
RENEWAL / REPLACEMENT
PROJECT

SURVEY CONTROL MAP
HARVEST MOON LIFT STATION

C3

WBS#: R-000267-0111-4

DRAWING SCALE:
1" = 100'

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 11 OF 190

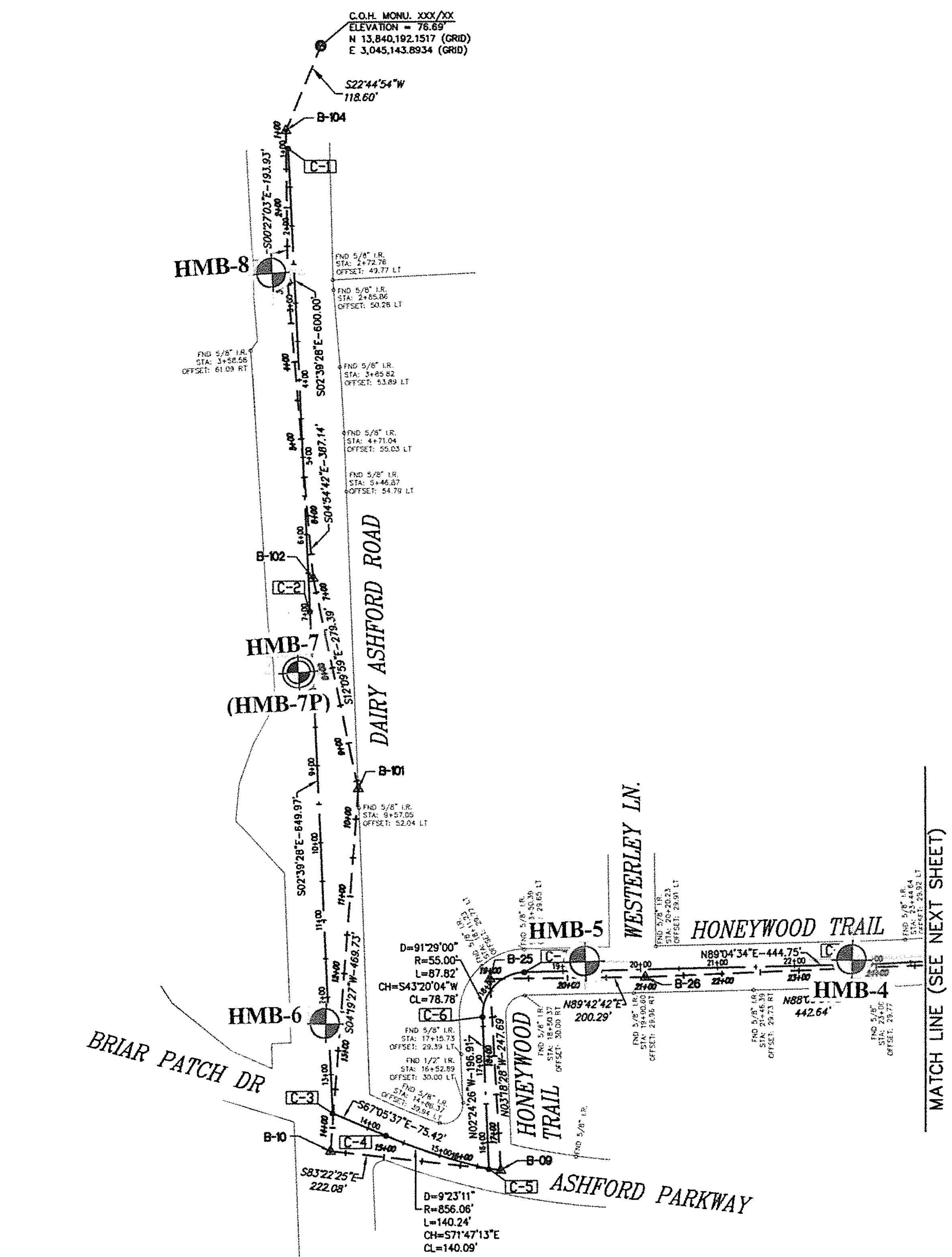
Legend:

Boring

FIGURE 2.5

Date\Time : Fri, 09 Aug 2013 - 6:24pm
Path\Name : S:\Proj-2013\13033 (COH LS ROUTE)\Dwgs\SCM\SCM-13033-Honeywood.dwg
Acad Version : R16.1s (LMS Tech)
User Name : luon

Job No. : 1140194901



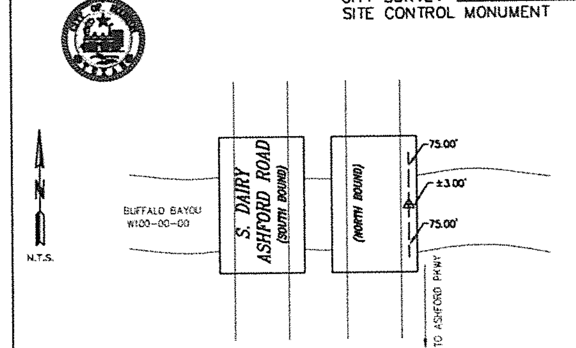
Legend:

Boring

Boring with Piezometer

CITY OF HOUSTON

CITY SURVEY
SITE CONTROL MONUMENT



Project WBS# R-000267-0111-4

Texas Coordinate System of 1983,
South Central Zone, U. S. Survey Feet

X= 3,045,143.8934

Y= 13,840,192.1517

Lat.= 29° 45' 42.81217" (N)

Lon.= 95° 36' 21.96431" (W)

Keymap Page: 488 M

Orthometric Elevation =76.69 FEET

Ellipsoid Height= -13.2533

Geoid: GEOID '12A

Datum Source & Adjustment: GPS STATIC

Reference Frame Used: NAD '83 (2011) (EPOCH: 2010)

Vertical Adjustment used: NAVD '88 (CORS '96)

General Location: ON NORTH BOUND BRIDGE OF DAIRY ASHFORD RD., APPROX. 0.3 MILE NORTH OF ASHFORD PKWY

Date Set: 05-15-2003 Type of Mark: BRASS DISK (HARRIS COUNTY FLOODPLAIN REFERENCE MARK 210180)

3 Nearest project control points (bearings and distances stated below):

1 S 08° 19' 01" W 306.51'
2 S 00° 55' 48" W 689.11'
3 S 10° 14' 57" E 1228.50'

NOTE:
1. Bearings are grid bearings.
2. Scale Factor = (S.F. 0.999891).
3. Surface= Grid / S.F.

Surveyed By: Kuo & Associates, Inc.
10700 Richmond Avenue, Suite 113
Houston, TX 77042

STATE OF TEXAS
REGISTERED
KUTUBUL A. M. MAHMOOD
6404
PROFESSIONAL
LAND SURVEYOR

Date Revised: 04-30-2013

City of Houston, Harris County, Texas

SCALE: 1" = 100'-0"

BENCHMARK:

CITY OF HOUSTON MONUMENT ____/____ AN HCFCD BRASS DISC (BEARING HARRIS COUNTY FLOODPLAIN REFERENCE MARK NUMBER 210180) ON BRIDGE AT S. DAIRY ASHFORD RD AND BUFFALO BAYOU LOCATED ON EAST SIDEWALK OF NORTHBOUND BRIDGE, AT STREAM CENTERLINE.

ELEV. 76.69 Feet NAVD 1988 (CORS96)*

* OBSERVED BY GPS SURVEYING AND PROCESSED IN REFERENCE TO THE CORS DATED APRIL 30, 2013 & GEOID '12A.

NOTE:

ALL BEARINGS AND DISTANCES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83 (CORS96). ALL DISTANCES ARE IN SURFACE.

THE COORDINATES SHOWN HEREON ARE TEXAS SOUTH CENTRAL ZONE NO. 4204 STATE PLANE GRID COORDINATES (NAD83) AND MAY BE BROUGHT TO SURFACE BY DIVIDING BY THE COMBINED SCALE FACTOR 0.999891.

LEGEND:

B-XX SURVEY CONTROL POINT NUMBER
C-X DESIGN BASELINE POINT NUMBER
SURVEY CONTROL POINT
DESIGN BASELINE POINT
CITY OF HOUSTON MONUMENT
D. BL: DESIGN BASELINE
S. BL: SURVEY BASELINE

SURVEY BASELINE POINTS DATA (TEMPORARY BENCHMARK)

T.B.M. No.	NORTHING (SURFACE)	EASTING (SURFACE)	NORTHING (GRID)	EASTING (GRID)	ELEV. (FT.)	S. BL STA.	D. BL STA.	OFFSET (FT.)	DESCRIPTION
B-9	13,840,244.74	3,045,708.72	13,838,736.15	3,045,376.74	75.29	16+52.28	N/A	N/A	SET "X" CUT ON CONC.
B-10	13,840,270.37	3,045,488.13	13,838,761.78	3,045,156.17	77.56	14+30.20	13+66.61	46.13 RT	SET "X" CUT ON CONC.
B-25	13,840,492.02	3,045,694.43	13,838,983.41	3,045,362.45	74.81	18+99.96	18+08.79	10.29 LT	SET "X" CUT ON CONC.
B-26	13,840,493.03	3,045,894.72	13,838,984.42	3,045,562.72	74.51	21+00.26	20+05.85	9.72 RT	SET "X" CUT ON CONC.
B-27	13,840,508.36	3,046,337.10	13,838,999.74	3,046,005.05	75.09	25+42.90	24+47.65	9.88 RT	SET "X" CUT ON CONC.
B-28	13,840,541.73	3,046,598.15	13,839,033.11	3,046,266.07	72.62	28+06.08	27+11.86	10.00 RT	SET "X" CUT ON CONC.
B-42	13,840,884.47	3,046,661.17	13,839,375.81	3,046,329.09	73.01	31+54.56	30+65.97	16.70 LT	SET "X" CUT ON CONC.
B-43	13,841,176.25	3,046,723.30	13,839,667.56	3,046,391.20	72.71	34+52.88	33+74.19	9.98 RT	SET "X" CUT ON CONC.
B-101	13,840,738.77	3,045,523.55	13,839,230.13	3,045,191.59	72.81	9+60.47	9+32.51	52.20 LT	SET 1/2" I.R. W/CAP
B-102	13,841,011.88	3,045,464.66	13,839,503.21	3,045,132.71	74.08	6+81.07	6+56.96	6.04 LT	SET "X" CUT ON CONC.
B-103	13,841,397.60	3,045,431.52	13,839,888.89	3,045,099.56	75.27	2+93.93	2+70.12	9.18 RT	SET "X" CUT ON CONC.
B-104	13,841,591.53	3,045,429.99	13,840,082.80	3,045,098.04	76.87	1+00	N/A	N/A	SET 1/2" I.R. W/CAP
B-131	13,841,156.04	3,047,385.99	13,839,647.35	3,047,053.82	68.30	41+82.14	41+23.43	3.16 RT	FND "X" CUT ON CONC.
B-133	13,841,316.72	3,046,979.85	13,839,808.02	3,046,647.73	71.31	37+45.38	N/A	N/A	FND "X" CUT ON CONC.
B-135	13,841,020.36	3,047,494.00	13,839,511.69	3,047,161.83	67.11	43+55.57	42+73.14	90.68 RT	SET 1/2" I.R. W/CAP

TEMPORARY BENCHMARKS

T.B.M. B-9
SET "X " CUT ON CONC. AT EAST SIDE OF ASHFORD PARKWAY AND HONEYWOOD TRAIL INTERSECTION.
ELEV.= 75.29'

T.B.M. B-10
SET "X " CUT ON CONC. AT SOUTH SIDE OF BRIAR PATCH DR. AND ASHFORD PARKWAY INTERSECTION.
D. STA: 13+66.61/46.13 RT
ELEV.= 77.56'

T.B.M. B-25
SET "X " CUT ON CONC. AT NORTHWEST SIDE OF HONEYWOOD TRAIL APPROX 156 FT. WEST OF HONEYWOOD TRAIL AND WESTERLY LN. INTERSECTION.
D. STA: 18+08.79/10.29 LT
ELEV.= 74.81'

T.B.M. B-26
SET "X " CUT ON CONC. AT SOUTHEAST SIDE OF HONEYWOOD TRAIL AND WESTERLY LN. INTERSECTION.
D. STA: 20+05.85/9.72 RT
ELEV.= 74.51'

T.B.M. B-27
SET "X " CUT ON CONC. AT SOUTH SIDE OF HONEYWOOD TRAIL APPROX 426 FT. EAST OF HONEYWOOD TRAIL AND WESTERLY LN. INTERSECTION.
D. STA: 24+47.65/9.88 RT
ELEV.= 75.09'

T.B.M. B-28
SET "X " CUT ON CONC. AT SOUTHWEST OF HONEYWOOD TRAIL AND HARVEST MOON ST. INTERSECTION.
D. STA: 27+11.86/10.00 RT
ELEV.= 72.62'

T.B.M. B-42
SET "X " CUT ON CONC. AT NORTHWEST CORNER OF BLACKSTONE CT. AND HARVEST MOON LN. INTERSECTION.
D. STA: 30+65.97/16.70 LT
ELEV.= 73.01'

T.B.M. B-43
SET "X " CUT ON CONC. AT NORTHEAST SIDE OF WESTERLEY LN. AND HARVEST MOON LN. INTERSECTION.
D. STA: 33+74.19/9.98 RT
ELEV.= 72.71'

T.B.M. B-101
SET 1/2 " I.R. W/CAP AT EAST SIDE OF DAIRY ASHFORD RD. APPROX. 407 FT. NORTH OF DAIRY ASHFORD RD. AND BRIAR PATCH DR. INTERSECTION.
D. STA: 9+32.51/52.20 LT
ELEV.= 72.81'

T.B.M. B-102
SET "X " CUT ON CONC. AT CENTER LINE OF DAIRY ASHFORD RD. APPROX. 668 FT. NORTH OF DAIRY ASHFORD RD. AND BRIAR PATCH DR. INTERSECTION.
D. STA: 6+56.96/6.04 LT
ELEV.= 74.08'

T.B.M. B-103
SET "X " CUT ON CONC. AT CENTER LINE OF DAIRY ASHFORD RD. APPROX. 1062 FT. NORTH OF DAIRY ASHFORD RD. AND BRIAR PATCH DR. INTERSECTION.
D. STA: 2+70.12/9.18 RT
ELEV.= 75.27'

T.B.M. B-104
SET 1/2 " I.R. W/CAP AT CENTER LINE OF DAIRY ASHFORD RD. APPROX. 1242 FT. NORTH OF DAIRY ASHFORD RD. AND BRIAR PATCH DR. INTERSECTION.
ELEV.= 76.87'

T.B.M. B-131
FND "X " CUT ON CONC. AT APPROX. 585 FT. EAST OF HARVEST MOON LN.
D. STA: 41+23.43/3.16 RT
ELEV.= 66.3'

T.B.M. B-133
FND "X " CUT ON CONC. AT APPROX. 167 NORTHEAST OF HARVEST MOON LN.
ELEV.= 71.31'

T.B.M. B-135
SET 1/2 " I.R. W/CAP AT APPROX. 752 FT. EAST OF HARVEST MOON LN.
D. STA: 42+73.14/90.68 RT
ELEV.= 67.11'

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Texas Registered Engineering Firm F-533

DATE: JULY 2013
JOB NO. TX000967.0006

DESIGNED BY: SC
DRAWN BY: CH

KUO & associates, Inc.
Consulting Engineers & Surveyors

SURVEYED BY: KUO & ASSOC.
FB NO.: P-XXXX

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SHAHEEN CHOWDHURY, R.P.L.S.
TEXAS REG. NO.: 5858
DATE: JULY 2013

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

LIFT STATION
RENEWAL / REPLACEMENT
PROJECT

SURVEY CONTROL MAP
HARVEST MOON LIFT STATION

C2

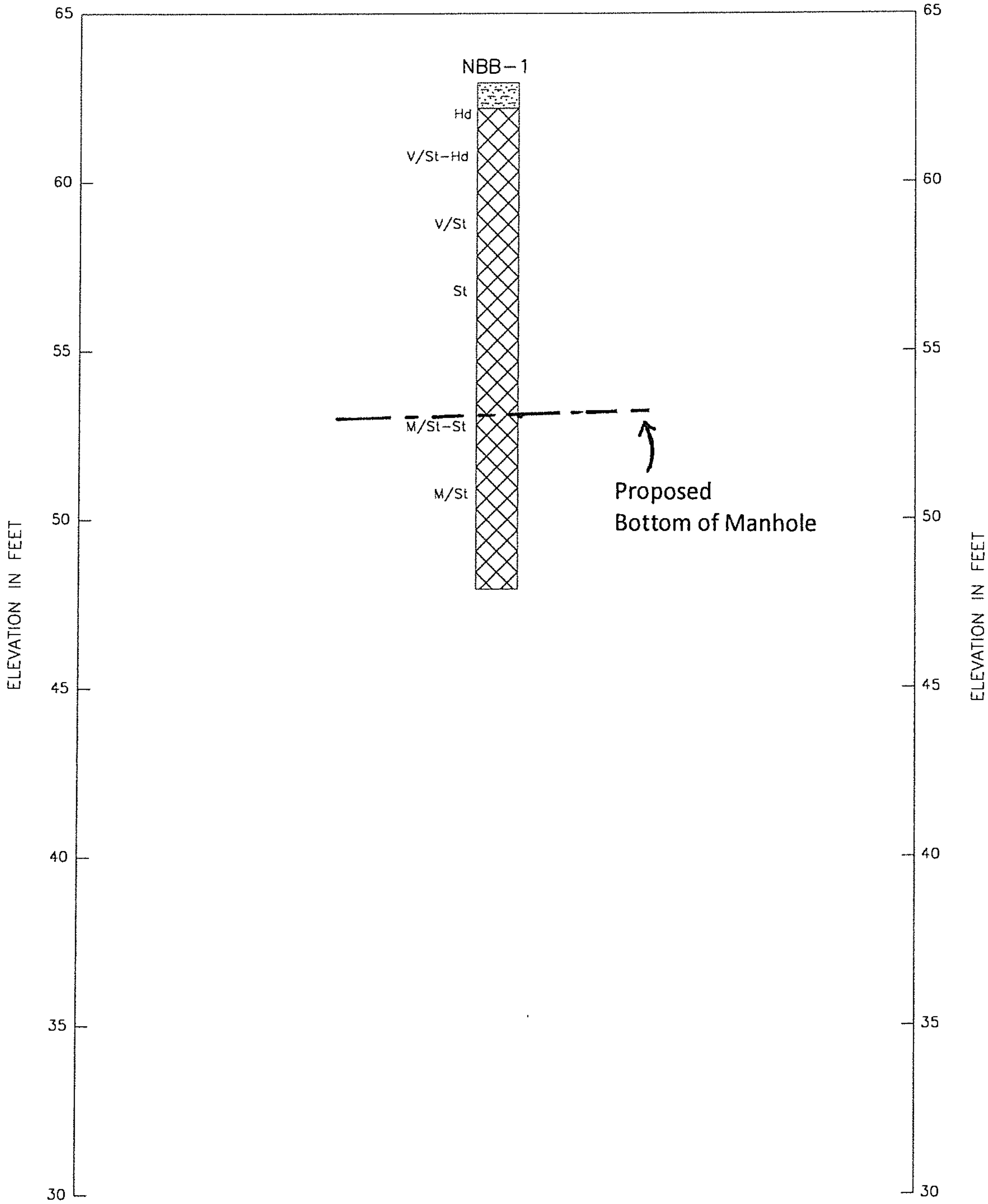
WBS#: R-000267-0111-4

DRAWING SCALE:
1" = 100'

CITY OF HOUSTON PM
TANU HIREMATH, P.E.

SHEET NO. 10 OF 190

FIGURE 2.6

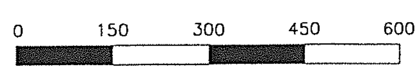


GENERAL NOTES:

1. See Figure 2.1 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Arcodis, U.S., Inc.

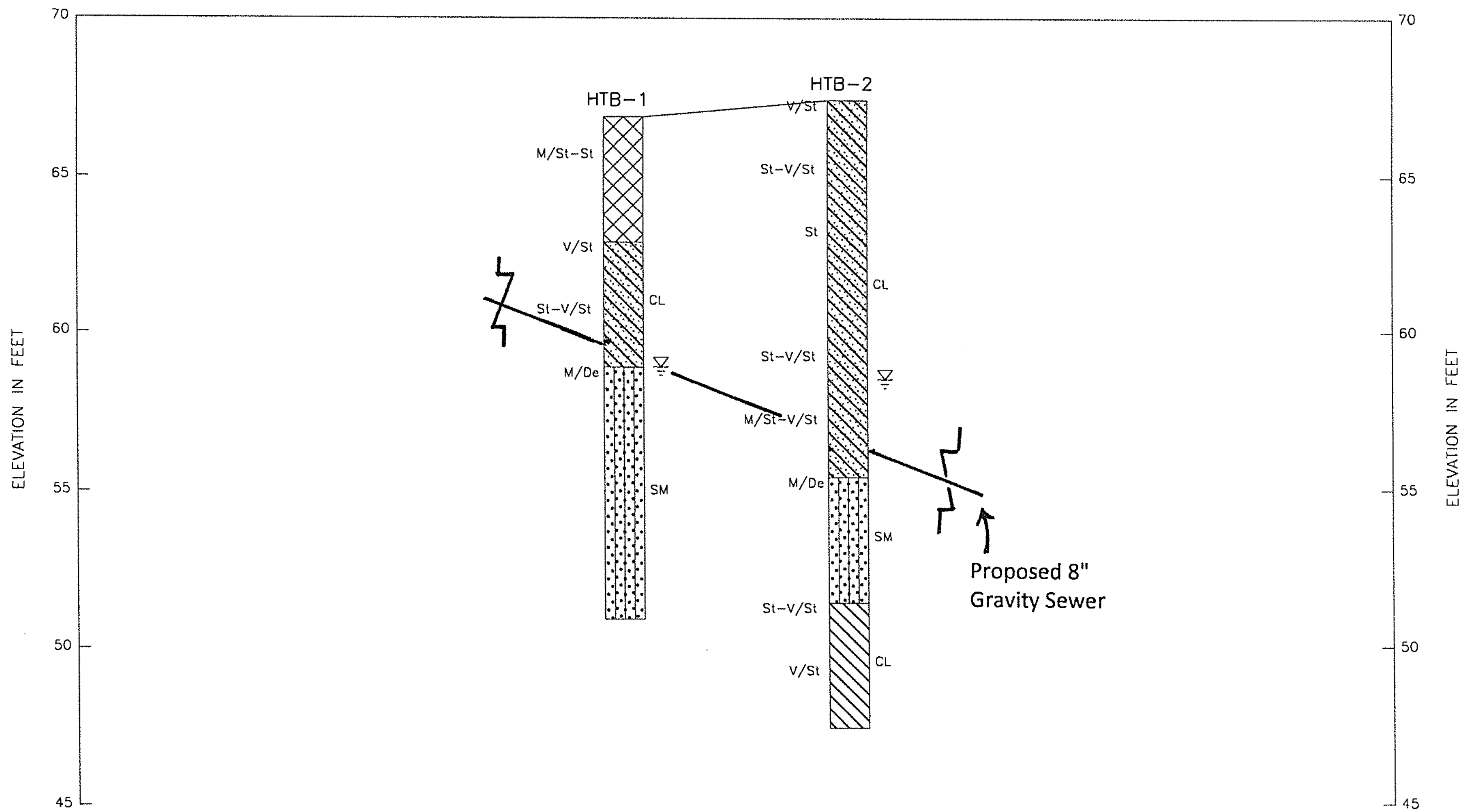
BORING LOG PROFILE

Northbrook Lift Station



Job No. 1140194901 *Geotest Engineering, Inc.*

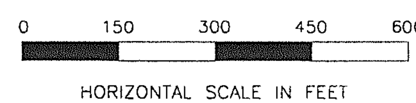
FIGURE 3.1

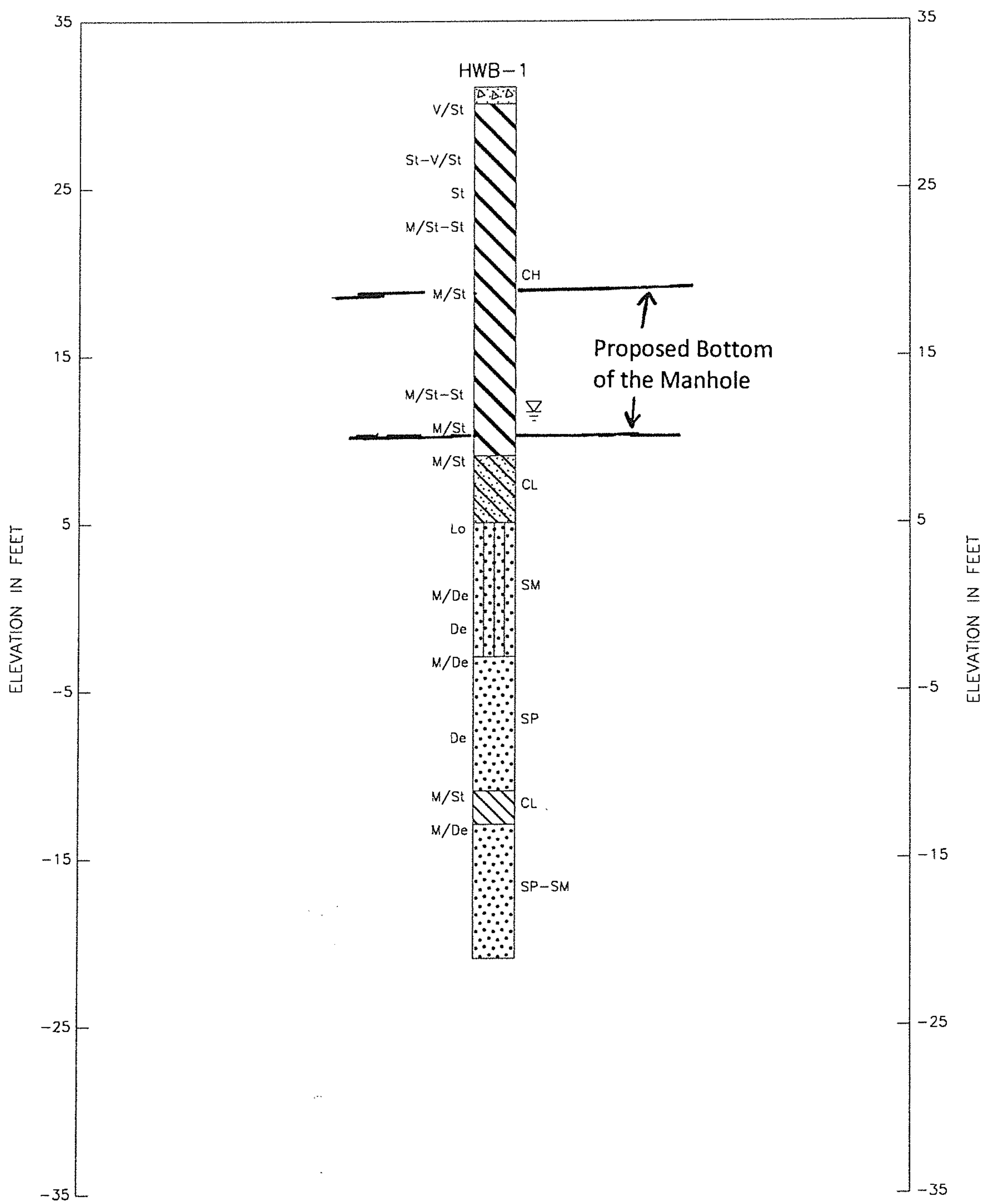


GENERAL NOTES:

1. See Figure 2.2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Arcadis, U.S., Inc.

BORING LOG PROFILE
Hardy Temp Lift Station





GENERAL NOTES:

1. See Figure 4 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure n for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Arcadis, U.S., Inc.

BORING LOG PROFILE

Hunterwood Lift Station

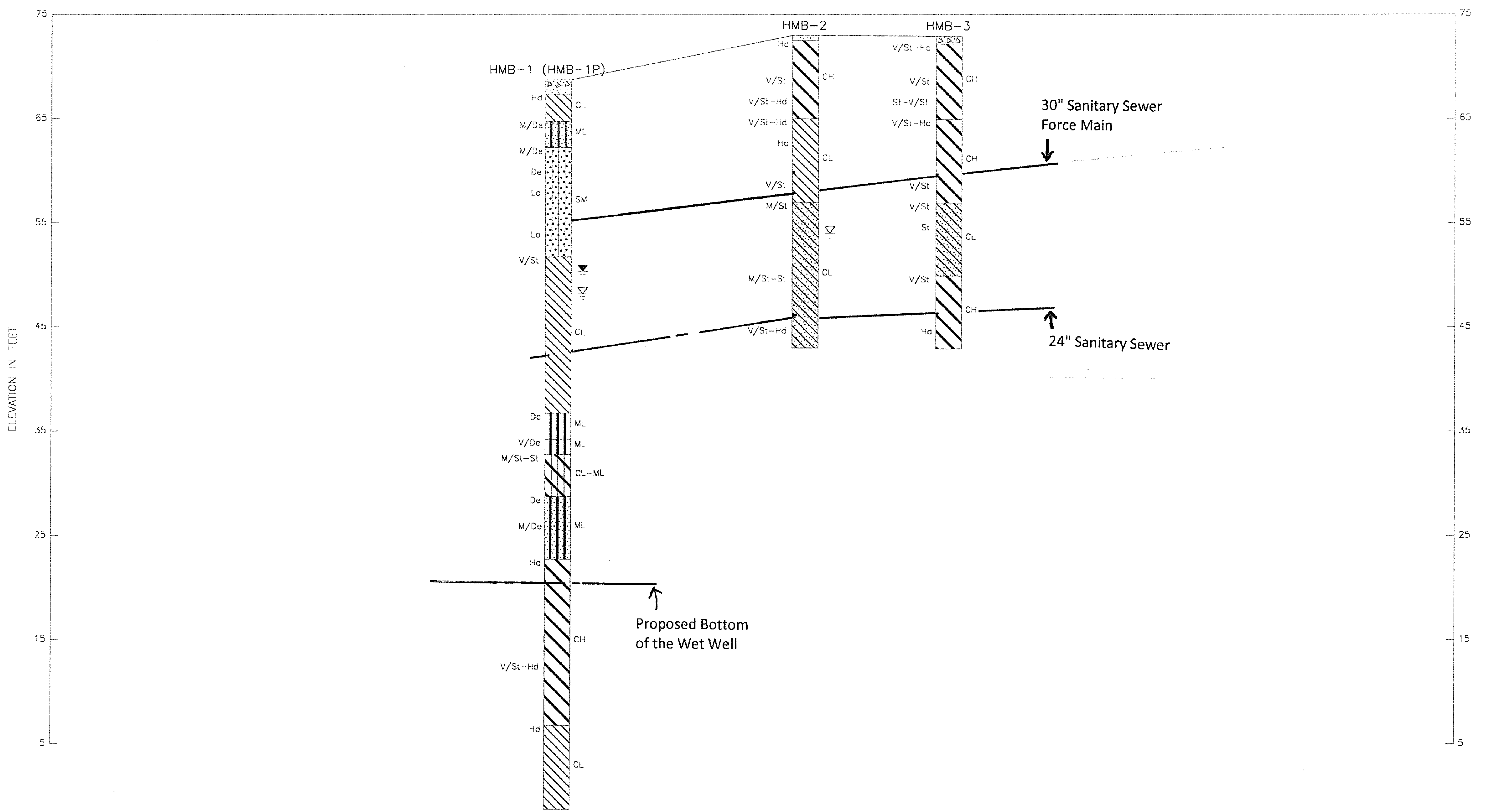
0 150 300 450 600

HORIZONTAL SCALE IN FEET

Job No. 1140194901

Geotest Engineering, Inc.

FIGURE 3.3

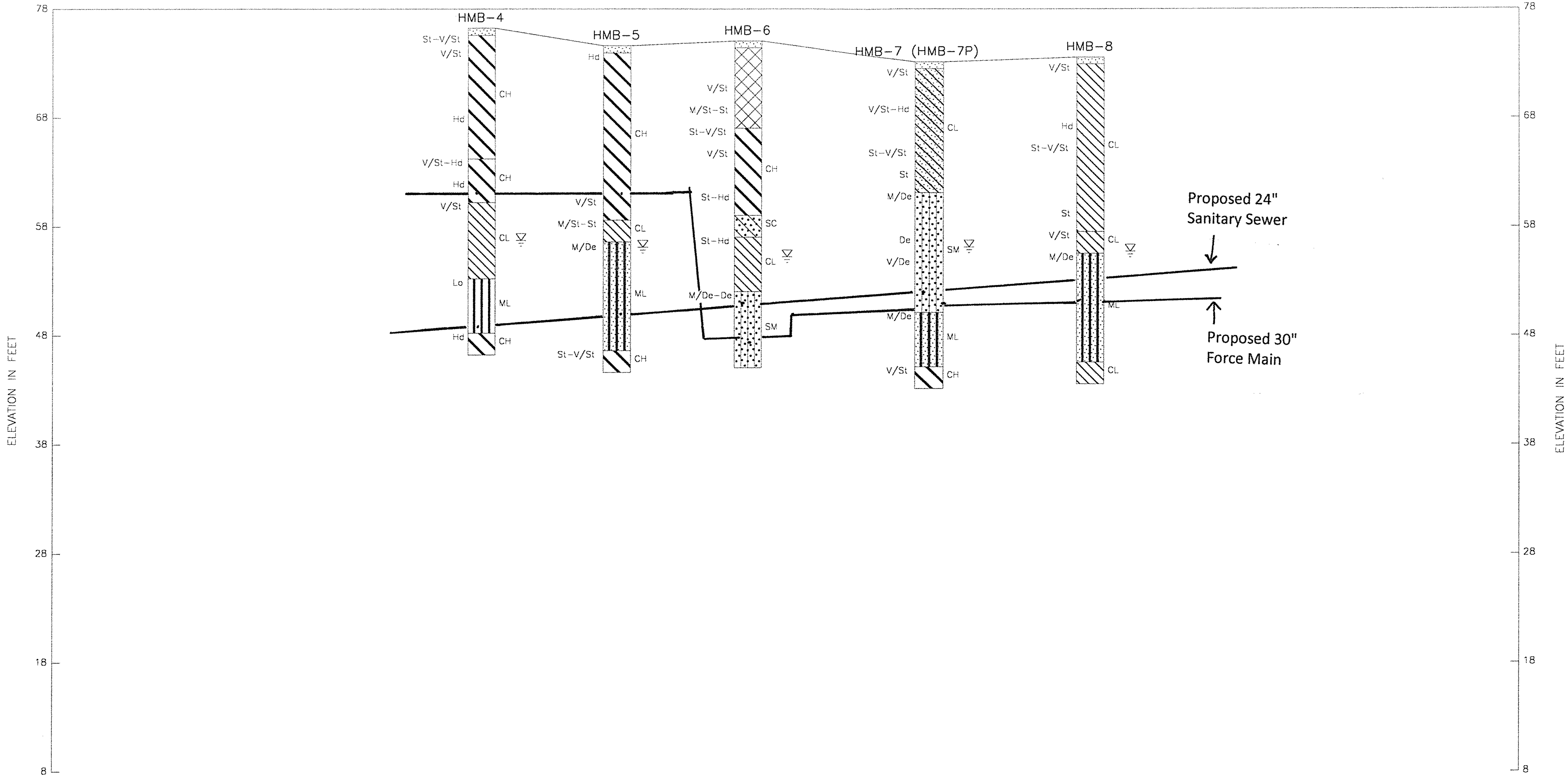


GENERAL NOTES:

1. See Figure 2.4 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Arcadis, U.S., Inc.

BORING LOG PROFILE
Harvest Moon Lift Station

0 150 300 450 600
HORIZONTAL SCALE IN FEET



GENERAL NOTES:

1. See Figures 2.5&2.6 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Arcadis, U.S., Inc.

BORING LOG PROFILE

Harvest Moon Lift Station

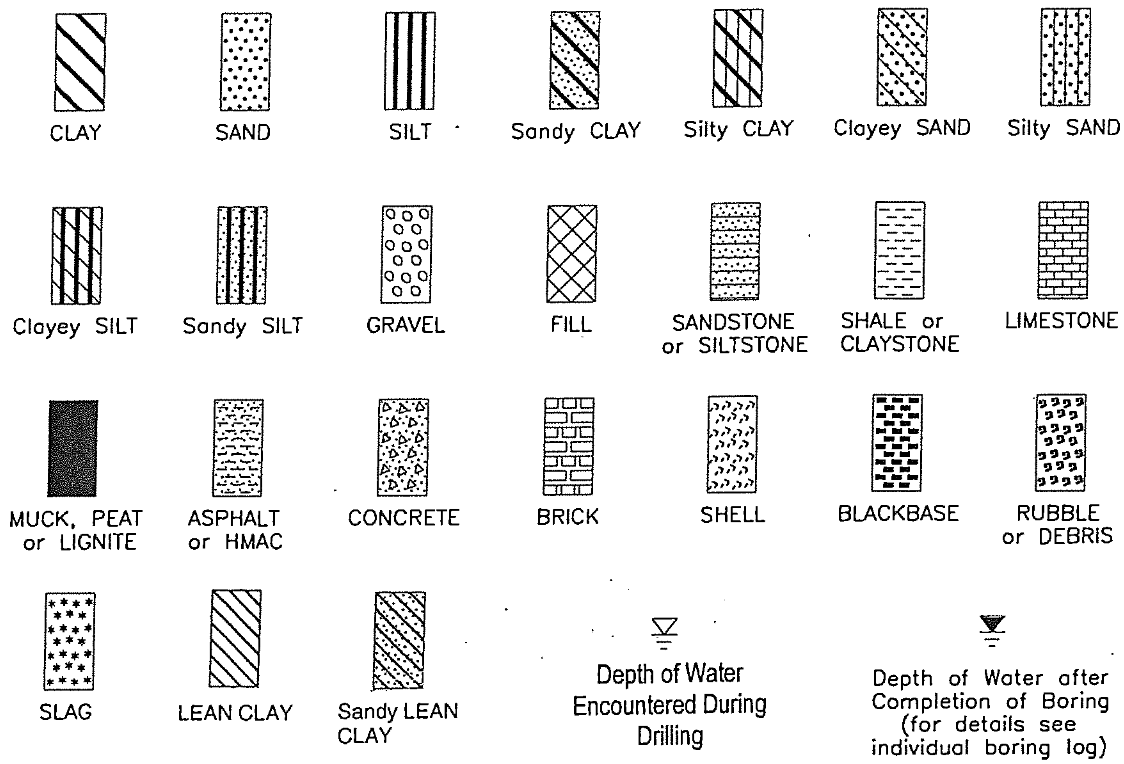
0 150 300 450 600

HORIZONTAL SCALE IN FEET

Job No. 1140194901

SYMBOLS AND ABBREVIATIONS USED ON BORING LOG PROFILE

LEGEND



ABBREVIATIONS USED FOR CONSISTENCY/DENSITY

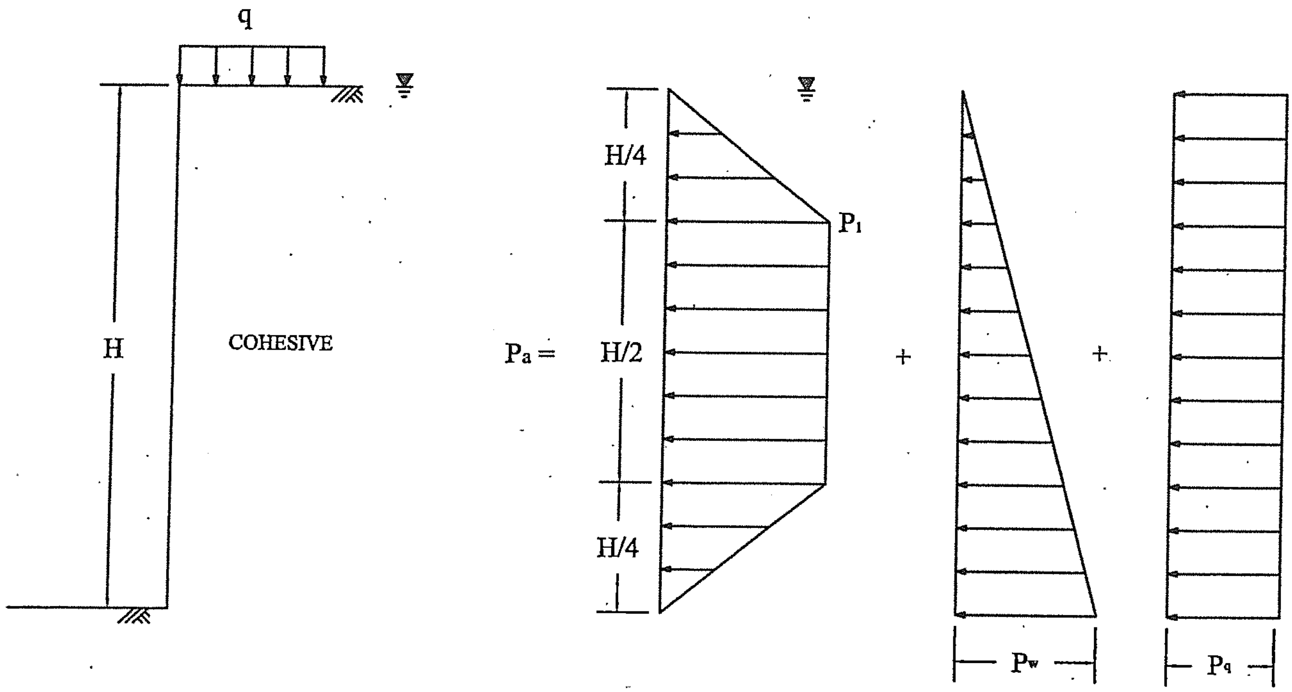
COHESIVE SOILS

V/So : Very Soft
So : Soft
Fm : Firm
M/St : Medium Stiff
St : Stiff
V/St : Very Stiff
Hd : Hard
V/Hd : Very Hard

COHESIONLESS SOILS

V/Lo : Very Loose
Lo : Loose
S/Co : Slightly Compact
Co : Compact
M/De : Medium Dense
De : Dense
V/De : Very Dense

Job No. 1140194901



TYPICAL SOIL PARAMETERS

BRACED WALL

See Table 2 for typical values of soil parameters

For $\gamma H/c \leq 4$

$P_1 = 0.3\ \gamma_c'\ H$
$P_w = \gamma_w\ H = 62.4\ H$
$P_q = 0.5\ q$

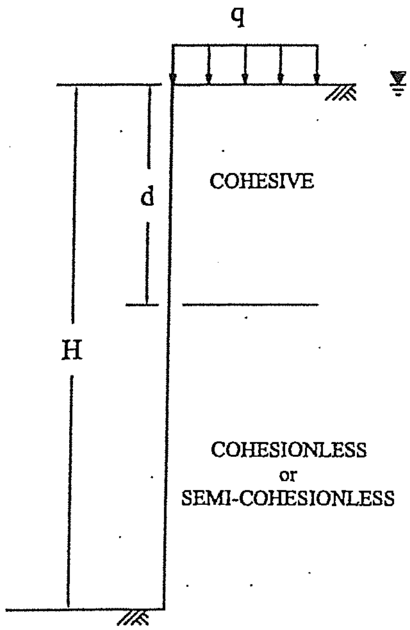
Where:

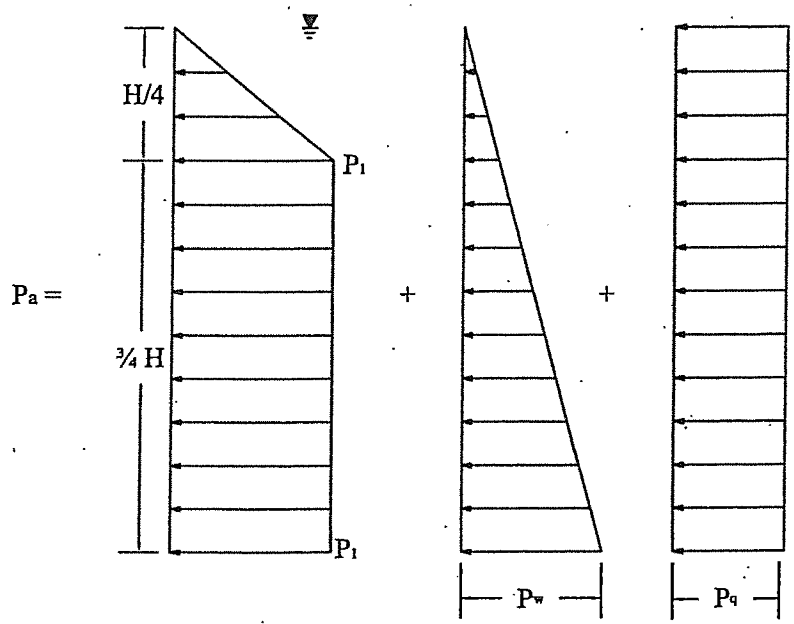
γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet
c = Shear strength of cohesion soil, psf;

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL

Job No. 1140194901





TYPICAL SOIL PARAMETERS

BRACED WALL

See Table 2 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (H-d)}{H}$$

$P_1 = 0.3\ \gamma'_{avg}\ H$
$P_w = 62.4\ H$
$P_q = 0.5\ q$

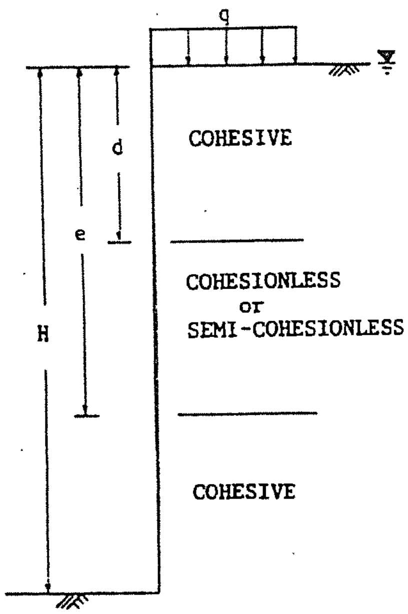
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless soil, pcf;
γ'_{avg} = Average submerged unit weight of soils, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet

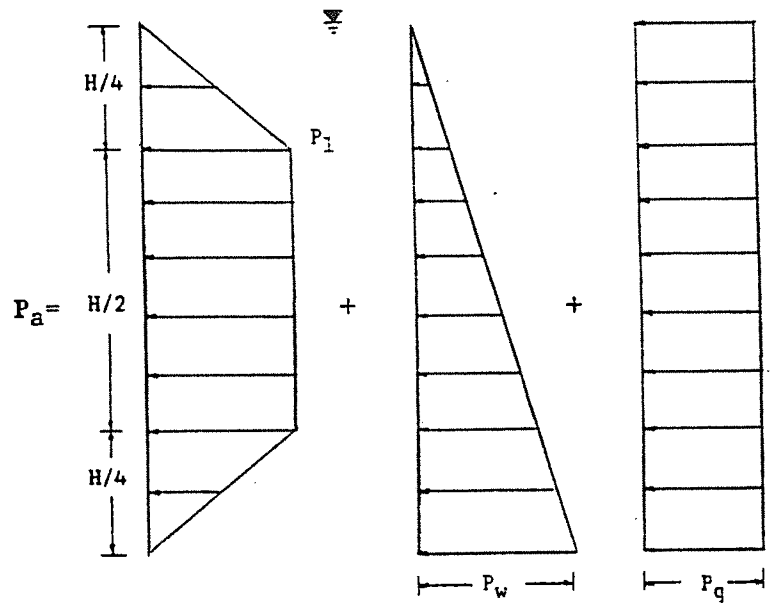
TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL OVER
COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140194901



TYPICAL SOIL PARAMETERS



BRACED WALL

See Table 2 for typical values of soil parameters

$P_1 = 0.3\ \gamma'_{avg}\ H$

$P_w = \gamma_w\ H = 62.4\ H$

$P_q = 0.5q$

$$\gamma'_{avg} = \frac{\gamma_c'\ d + \gamma_s'\ (e-d) + \gamma_c'\ (H-e)}{H}$$

$$\gamma_w = 62.4\ \text{pcf}$$

Where:

- γ_c' = Submerged unit weight of cohesive soil, pcf ;
- γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf ;
- γ_w = Unit weight of water, pcf;
- γ'_{avg} = Average submerged unit weight of soil, pcf ;
- q = Surcharge load at surface, psf;
- P_a = Lateral pressure, psf;
- P_1 = Active earth pressure, psf;
- P_q = Horizontal pressure due to surcharge, psf;
- P_w = Hydrostatic pressure due to groundwater, psf;
- H = Depth of braced excavation, feet

TRENCH SUPPORT EARTH PRESSURE

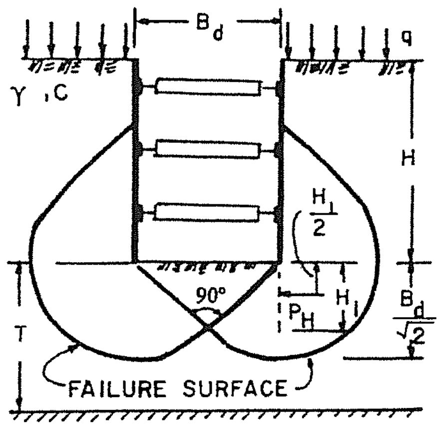
SUBMERGED COHESIVE SOIL INTERBEDDED WITH COHESIONLESS OR SEMI-COHESIONLESS SOIL

Geotest Engineering, Inc.

FIGURE 5.3

Job No. 1140194901

CUT IN COHESIVE SOIL,
DEPTH OF COHESIVE SOIL UNLIMITED ($T > 0.7\ B_d$)
L = LENGTH OF CUT



If sheeting terminates at base of cut:

$$\text{Safety factor, } F_S = \frac{N_C C}{\gamma H + q}$$

N_C = Bearing capacity factor, which depends on dimensions of the excavation : B_d , L and H (use N_C from graph below)

C = Undrained shear strength of clay in failure zone beneath and surrounding base of cut

γ = Wet unit weight of soil (see Table 2)

q = Surface surcharge (assume q = 500 psf)

If safety factor is less than 1.5, sheeting or soldier piles must be carried below the base of cut to insure stability - (see note)

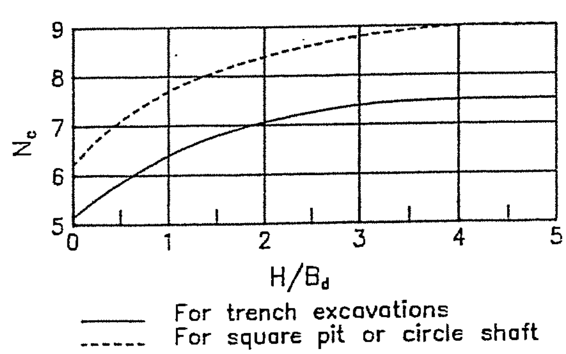
$$H_1 = \text{Buried length} = \frac{B_d}{2} \geq 5 \text{ feet}$$

Note : If soldier piles are used, the center to center spacing should not exceed 3 times the width or diameter of soldier pile .

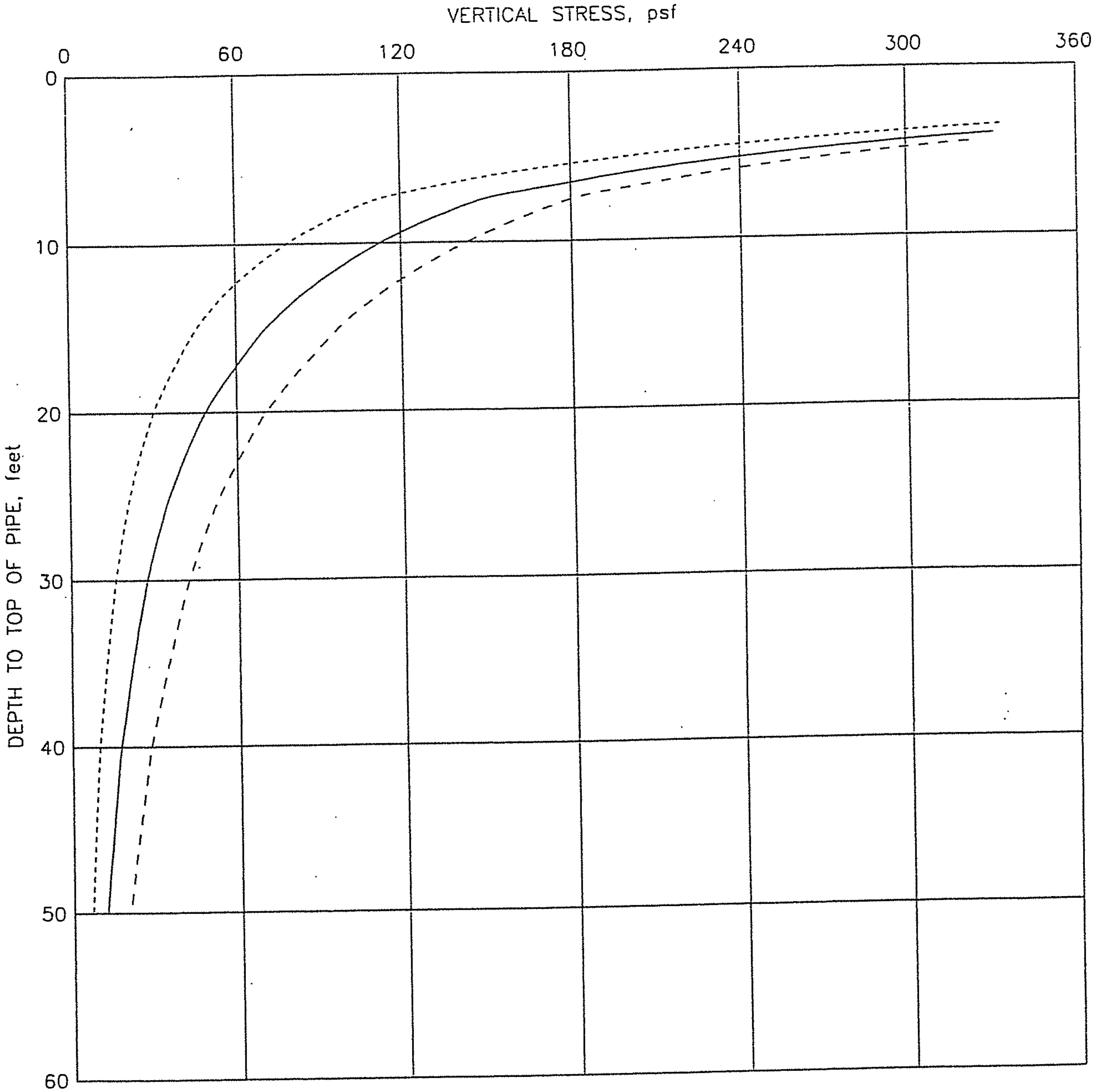
Force on buried length, P_H:

If $H_1 > \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 0.7\ (\gamma\ HB_d - 1.4CH - \pi CB_d)$ in lbs/ linear foot

If $H_1 < \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 1.5H_1\ (\gamma\ H - \frac{1.4CH}{B_d} - \pi C)$ in lbs/ linear foot



STABILITY OF BOTTOM FOR BRACED CUT



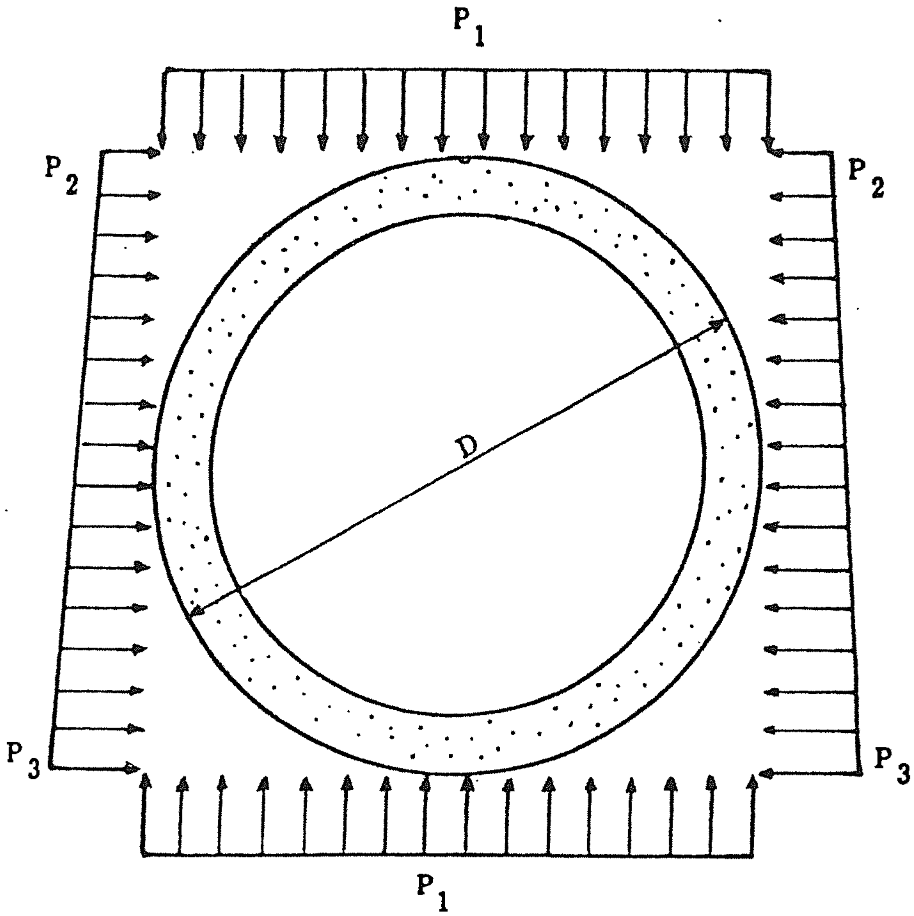
Legend:

- ------ One passing truck
- ______ Two passing trucks
- _ _ _ Four passing trucks

Notes: 1. The verticol stress wos estimoted using AASHTO H20 or HS20 truck oxle loadings on poved surfaces.
2. Impact factor was included in the vertical stress.

VERTICAL STRESS ON PIPES
DUE TO TRAFFIC LOADS

Job No. 1140194901



$$P_1 = [(H + \frac{D}{2}) \times (\gamma - \gamma_w) + D_w \times \gamma_w] + q_s \text{, for } D_w < H + \frac{D}{2}$$

$$P_1 = [(H + \frac{D}{2}) \times \gamma] + q_s \text{, for } D_w \geq H + \frac{D}{2}$$

$$P_2 = (H \times \gamma) + q_s$$

$$P_3 = [(H + D) \times \gamma] + q_s$$

Where: P_1, P_2, P_3 = Tunnel liner load, psf.

D = Tunnel outside diameter, ft.

H = Depth to top of tunnel; ft.

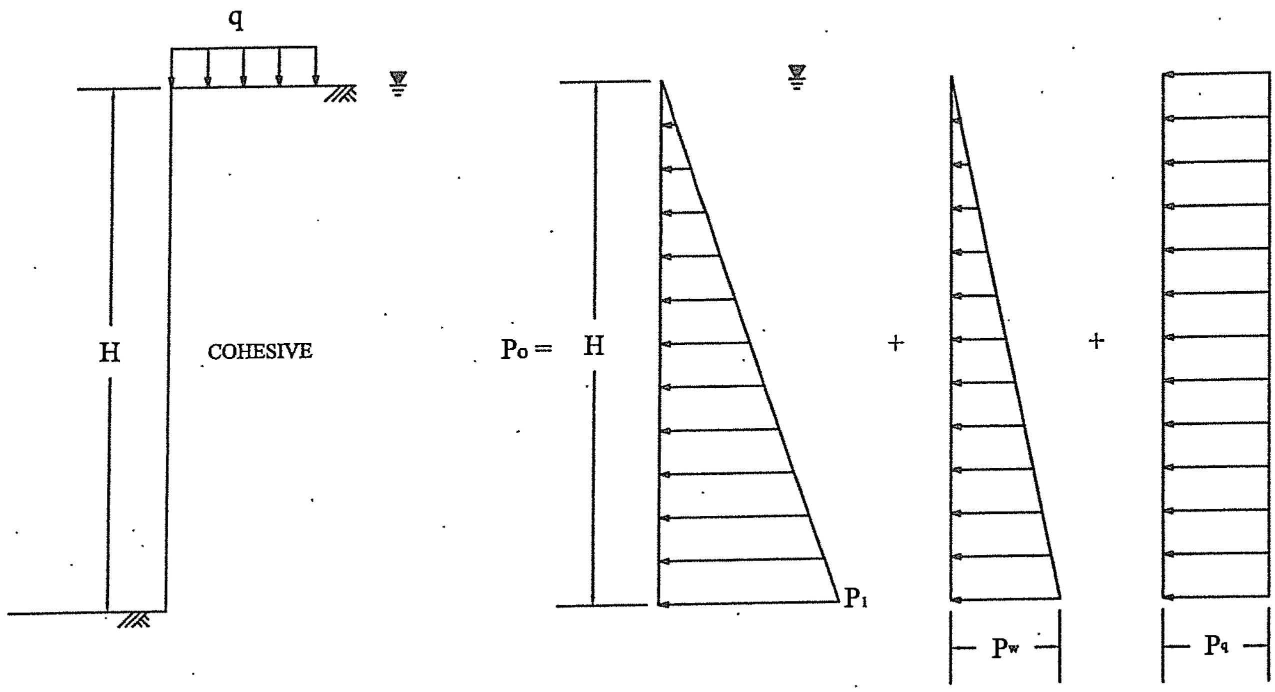
D_w = Depth to ground water level; ft.

γ = Wet unit weight of soil, pcf (see Table 3)

γ_w = Unit weight of water, 62.4 pcf

q_s = Surcharge load, psf.

EARTH PRESSURE
ON PIPE AND CASING AUGERING



TYPICAL SOIL PARAMETERS

See Table 2 for typical
values of soil parameters

$K_{oc} = 1.0$

PERMANENT WALL

$P_1 = K_{oc}\,\gamma_c'\,H$
$P_w = \gamma_w\,H = 62.4\,H$
$P_q = 0.5\,q$

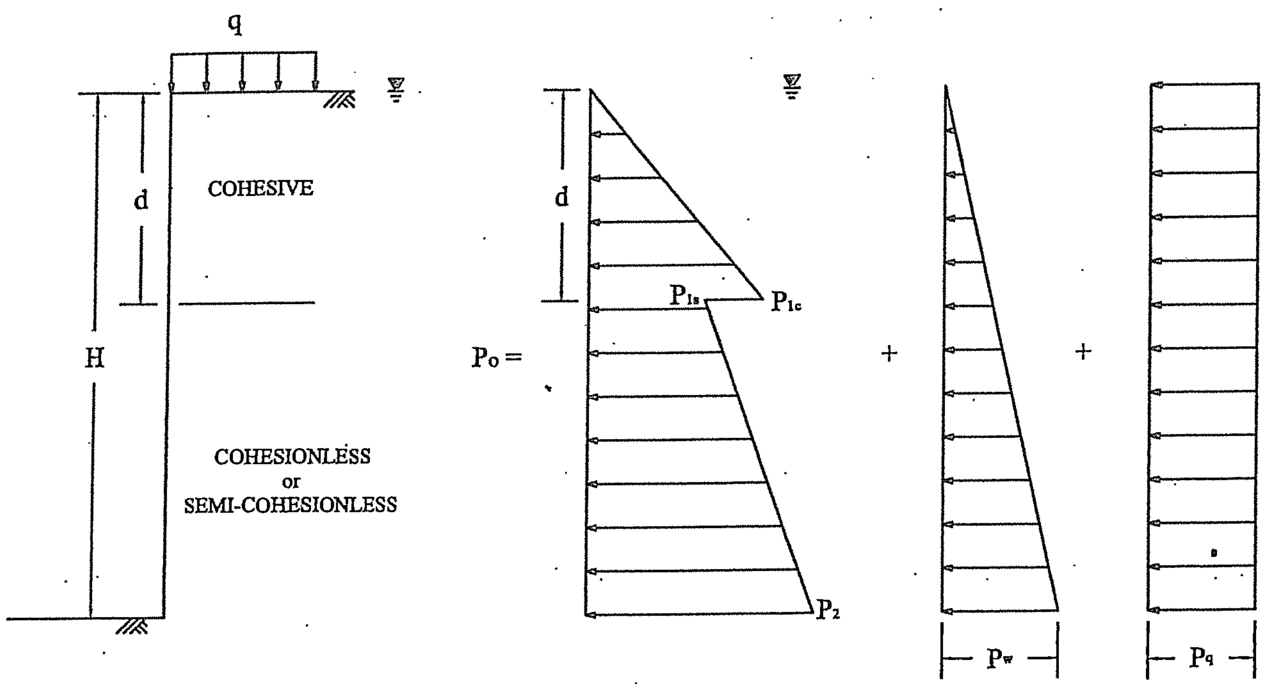
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_1 = At-rest earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of excavation, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL

Job No. 1140194901



TYPICAL SOIL PARAMETERS

PERMANANT WALL

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$
$K_{os} = 1\text{-}\sin\phi_s$

$P_{1c} = \gamma_c'\, d\, K_{oc}$
$P_{1s} = \gamma_c'\, d\, K_{os}$
$P_2 = [\gamma_c'\, d + \gamma_s'\, (H\text{-}d)]\, K_{os}$
$P_w = \gamma_w\, H = 62.4\, H$
$P_q = 0.5\, q$

Where:

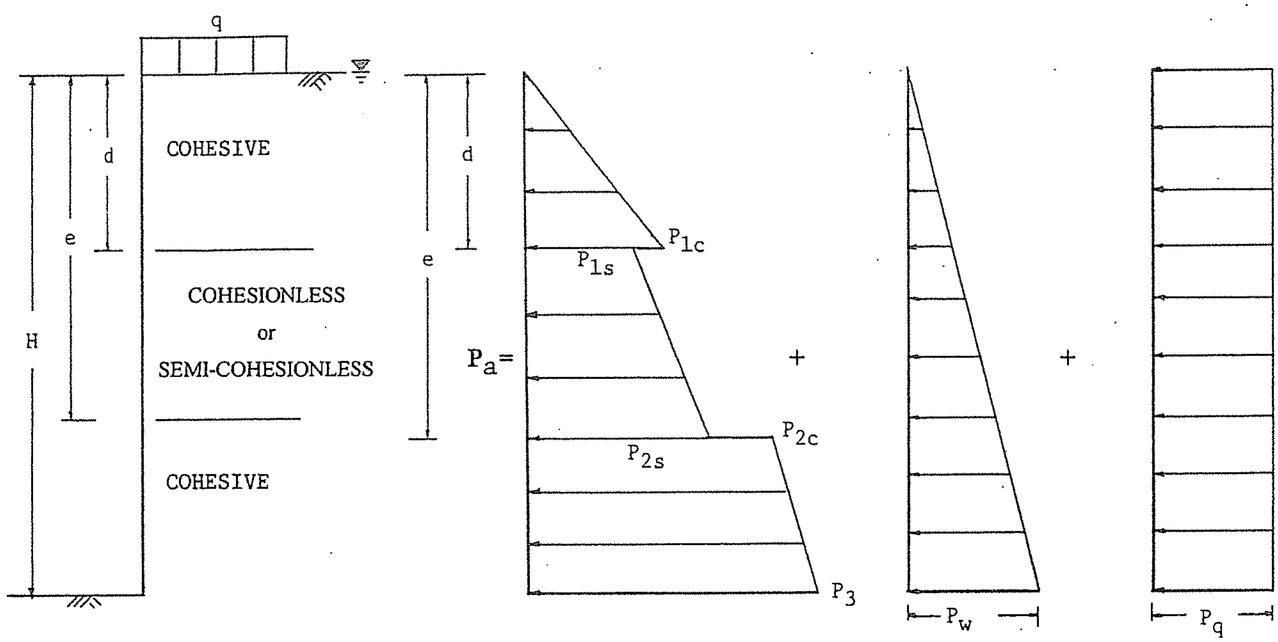
γ_c' = Submerged unit weight of cohesive soil, pcf;
γ'_s = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
K_{os} = Coefficient of at-rest earth pressure in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = At-rest earth pressure, psf; i = 1, 2;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL OVER COHESIONLESS OR SEMI-COHESIONLESS SOIL

Geotest Engineering, Inc.

FIGURE 9.2



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

$K_{os} = 1 - \sin\phi_s$

$\gamma_w = 62.4$ psf

PERMANENT WALL

$P_{1c} = \gamma'_c\, d\, K_{oc}$

$P_{1s} = \gamma'_c\, d\, K_{os}$

$P_{2s} = P_{1s} + \gamma'_s\, (e-d)\, K_{os}$

$P_{2c} = [\gamma'_c\, d + \gamma'_s\, (e-d)]\, K_{oc}$

$P_3 = [\gamma'_c\, d + \gamma'_s\, (e-d) + \gamma'_c\, (H-e)\,]\, K_{oc}$

$P_w = \gamma_w H = 62.4\, H$

$P_q = 0.5\, q$

Where:

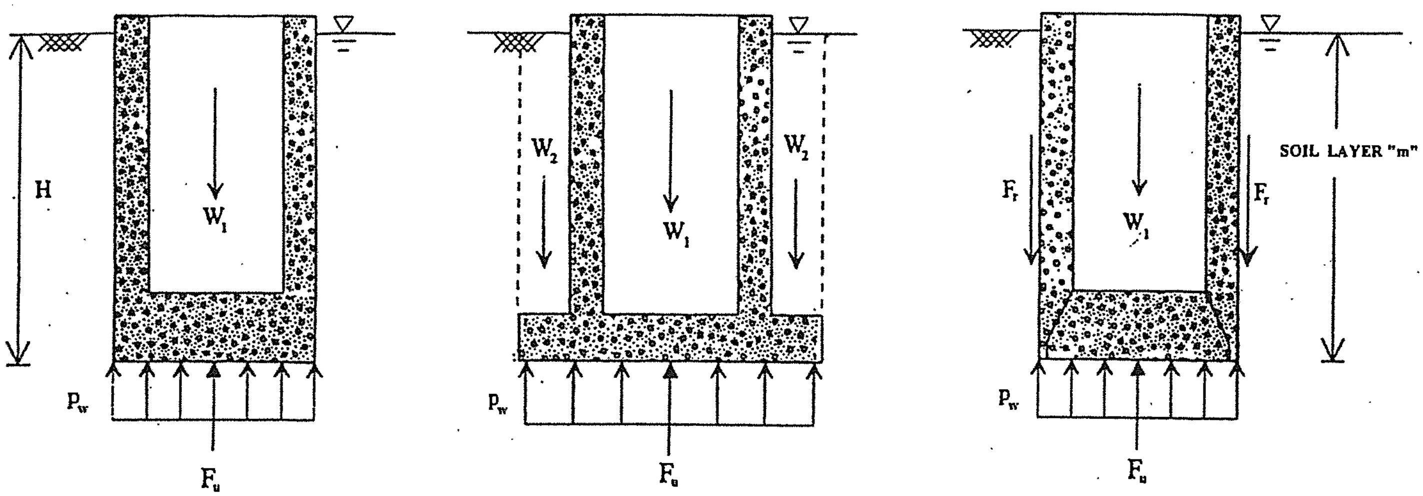
γ_c' = Effective unit weight of cohesive soil, pcf;
γ_s' = Effective unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of earth pressure at rest in cohesive soils;
Ko_{as} = Coefficient of earth pressure at rest in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = Earth pressure at rest, psf; i = 1, 2, 3;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM
FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL
INTERBEDDED WITH COHESIONLESS
OR SEMI-COHESIONLESS SOIL

Job No. 1140194901

(a) DEAD WEIGHT OF STRUCTURE — **(b) WEIGHT OF SOIL ABOVE BASE EXTENSION PLUS DEAD WEIGHT OF STRUCTURE** — **(c) SOIL-WALL FRICTION PLUS DEAD WEIGHT OF STRUCTURE**



(a)

$p_w = H\gamma_w$

$F_u = A_b p_w$

$$\frac{W_1}{Sf_1} = F_u$$

(b)

$p_w = H\gamma_w$

$F_u = A_b p_w$

$$\frac{W_1}{Sf_1} + \frac{W_2}{Sf_2} = F_u$$

(c)

$p_w = H\gamma_w$

$F_u = A_b p_w$

$$\frac{W_1}{Sf_1} + \frac{F_r}{Sf_3} = F_u$$

Predominantly Cohesive Soils, $F_r = \alpha\, c_m A_m$

Predominantly Cohesionless Soils, $F_r = p_m A_m K \tan \delta_m$

See Table 2 for typical values of soil parameters

Where:

A_b	=	area of base, sq. ft.
A_m	=	cylindrical surface area of layer "m" , sq. ft.
c_m	=	undrained cohesion of soil layer "m", psf.
F_u	=	hydrostatic uplift force, lbs.
F_r	=	frictional resistance, lbs.
H	=	height of buried structure, ft.
K	=	coefficient of lateral pressure = 0.5.
p_m	=	average overburden pressure for layer "m," psf.
p_w	=	hydrostatic uplift pressure, psf.
$Sf_{1,2,3}$	=	factor of safety.
W_1	=	dead weight of concrete structure, lbs.
W_2	=	weight of backfill above base extension, lbs.
α	=	cohesion reduction factor = 0.5.
δ_m	=	friction angle between soil layer "m" and concrete wall, degrees = 0.75 ϕ_m
ϕ_m	=	internal angle of friction of soil layer "m", degrees.
γ_w	=	unit weight of water = 62.4 pcf.

UPLIFT PRESSURE AND RESISTANCE

TABLES

TABLE 1

SUMMARY OF BORING INFORMATION

Lift Station	Street Name	Boring No.	Boring Depth (feet)	Northing[(1)]	Easting[(1)]	Ground Surface Elevation (feet) [(1)]
Northbrook LS		NBB-1	15	13798493.124	3072320.359	31.07
Hardy Temp LS		HTB-1	16	13874905.543	3122565.574	66.89
		HTB-2	20	13875146.324	3122915.129	67.42
Hunterwood		HWB-1	52	13865469.328	3171961.948	31.07
Harvest Moon		HMB-1 (HMB-1P)	70	13841099.038	3047437.251	68.74
	Harvest Moon Ln	HMB-2	30	13841228.948	3046737.508	72.98
	Harvest Moon Ln	HMB-3	30	13840824.014	3046650.885	72.90
	Honeywood Trail	HMB-4	30	13840512.584	3046175.108	76.23
	Honeywood Trail	HMB-5	30	13840507.843	3045799.832	74.61
	Dairy Ashford Rd	HMB-6	30	13840420.635	3045450.614	75.05
	Dairy Ashford Rd	HMB-7 (HMB-7P)	30	13840919.654	3045429.022	73.12
	Dairy Ashford Rd	HMB-8	30	13841367.337	3045404.05	73.55

Notes:

(1) The survey information for the completed borings was provided to us by ARCADIS.

TABLE 2

GEOTECHNICAL DESIGN PARAMETER SUMMARY OPEN-CUT EXCAVATION

Lift Station	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
Northbrook	NBB-1	FILL	0-6	125	63	2,000	--
			6-10	125	63	1,000	--
			10-15	120	60	500	--
Hardy Temp	HTB-1	FILL	0-4	120	60	800	--
		Cohesive	4-8	130	65	1,200	--
		Cohesionless	8-16	108	54	--	30
	HTB-2	Cohesive	0-10	125	63	1,200	--
			10-12	130	65	800	--
		Cohesionless	12-16	110	55	--	30
		Cohesive	16-20	125	63	1,600	--
Huterwood	HWB-1	Cohesive	0-6	120	60	1,500	--
			6-10	125	63	1,000	--
			10-26	120	60	500	--
		Cohesionless	26-34	100	50	--	28
			34-42	104	52	--	30
		Cohesive	42-44	125	63	600	--
		Cohesionless	44-52	106	53	--	30
Harvest Moon	HMB-1	Cohesive	0-4	125	63	4,000	--
		Cohesionless	4-6.5	104	52	--	28
			6.5-17	100	50	--	30
		Cohesive	17-26	130	65	1,500	--
			26-32	126	63	600	--
		Cohesionless	32-36	100	50	--	28
		Cohesive	36-40	125	63	500	--
		Cohesionless	40-46	102	51	--	28
		Cohesive	46-55	125	63	4,500	--
			55-62	125	63	3,500	--
			62-70	130	65	4,500	--
	HMB-2 & HMB-3	Cohesive	0-8	125	63	1,200	--
			8-16	130	65	2,000	--
			16-23	125	63	600	--
			23-30	125	63	2,200	--
	HMB-4	Cohesive	0-2	120	60	1,000	--
			2-12	130	65	2,500	--
			12-16	130	65	2,800	--
			16-23	130	65	2,200	--
		Cohesionless	23-28	98	49	--	25
		Cohesive	28-30	125	63	4,500	--
	HMB-5	Cohesive	0-15	128	64	4,500	--
			15-18	120	60	1,000	--
		Cohesionless	18-28	106	53	--	30
		Cohesive	28-30	125	63	800	--
	HMB-6	FILL	0-4	125	63	2,200	--
			4-6	120	60	500	--
		Cohesive	6-16	125	63	1,500	--
		Cohesionless	16-18	110	55	--	30
		Cohesive	18-23	125	63	1,800	--
		Cohesionless	23-30	110	55	--	30

TABLE 2 (cont'd)

GEOTECHNICAL DESIGN PARAMETER SUMMARY OPEN-CUT EXCAVATION

Lift Station	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
	HMB-7	Cohesive	0-8	126	63	3,000	--
			8-12	125	63	1,000	--
		Cohesionless	12-23	112	56	--	30
			23-28	125	63	--	28
		Cohesive	28-30	124	52	1,500	--
	HMB-8	Cohesive	0-10	130	65	2,000	--
			10-12	125	63	1,500	--
			12-14	125	63	500	--
			14-18	125	63	3,000	--
		Cohesionless	18-28	106	53	--	28
		Cohesive	28-30	125	63	1,500	--

Notes:

1. Fill soil includes Fat Clay, Lean Clay w/shell, gravel and calcareous nodules.
2. Cohesive soils include Fat clay, Lean clay, Lean clay w/sand, Silty Clay and Sandy Lean clay.
3. Cohesionless soils include Silty Sand, Silt w/sand, Silt and Clayey Silt.

TABLE 3.1
GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION AT
HARDY TEMP LIFT STATION
(HTB-1 AND HTB-2)

PROPERTY		COHESIVE SOILS (1)	COHESIONLESS SOILS (2)
Wet Unit Weight, γ, pcf	0-4	120	--
	4-8	130	--
	8-12	125	**108** (HTB-1 only)
	12-16	--	**108**
	16-20	125	--
Submerged Unit Weight, γ′, pcf	0-4	60	--
	4-8	65	--
	8-12	63	**54** (HTB-1 only)
	12-16	--	**54**
	16-20	63	--
Moisture Content (%)	0-4	14	--
	4-8	14	--
	8-12	15	**15** (HTB-1 only)
	12-16	--	**20**
	16-20	25	--
UNDRAINED PROPERTIES *			
Undrained Cohesion, C_u, psf	4-8*	1,000	--
	8-12*	800	--
	12-16*	--	--
Angle of Internal, ϕ, degrees	4-8*	--	--
	8-12*	--	**30** (HTB-1 only)
	12-16*	--	**30**
Elastic Modulus, E, psf	4-8*	400,000	--
	8-12*	320,000	**168,000** (HTB-1 only)
	12-16*	--	**168,000**
Coefficient of Lateral Earth Pressure at Rest, K_o	4-8*	1.2	--
	8-12*	1.2	**0.5** (HTB-1 only)
	12-16*	--	**0.5**
Poisson's Ratio		0.45	0.3
DRAINED PROPERTIES *			
Drained Cohesion, C′, psf	4-8*	0	--
	8-12*	0	--
	12-16*	0	--
DRAINED PROPERTIES *			
Angle of Internal Friction, ϕ′, degrees	4-8*	24	--
	8-12*	24	**30** (HTB-1 only)
	12-16*	--	**30**
Elastic Modulus, E, psf	4-8*	240,000	--
	8-12*	192,000	**168,000** (HTB-1 only)
	12-16*	--	**168,000**

Notes:
1. Cohesive soils include lean clay w/sand and sandy lean clay.
2. Cohesionless soils include silty sand.

* Within tunneling zone (one bore diameter, but not less than 6 feet, above and below tunnel bore).

TABLE 3.2
GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION HARVEST MOON LIFT STATION
(HMB-1 through HMB-8)

PROPERTY		COHESIVE SOILS [1]	COHESIONLESS SOILS [2]
Wet Unit Weight, γ, pcf	0-4	120	--
	4-12	125	100 (HMB-1 only)
	12-16	120	104 (HMB-1 and HMB-7 only)
	16-18	130	104 (HMB-1, HMB-6 and HMB-7 only)
	18-23	125	106 (HMB-5, HMB-7 and HMB-8)
	23-28	125	98 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30	120	110 (HMB-6 only)
Submerged Unit Weight, γ′, pcf	0-4	60	--
	4-12	63	50 (HMB-1 only)
	12-16	60	52 (HMB-1 and HMB-7 only)
	16-18	65	52 (HMB-1, HMB-6 and HMB-7 only)
	18-23	63	53 (HMB-5, HMB-7 and HMB-8)
	23-28	63	49 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30	60	55 (HMB-6 only)
Moisture Content (%)	0-4	18	--
	4-12	20	11 (HMB-1 only)
	12-16	21	6 (HMB-1 and HMB-7 only)
	16-18	23	16 (HMB-1, HMB-6 and HMB-7 only)
	18-23	11	19 (HMB-5, HMB-7 and HMB-8)
	23-28	15	18 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30	12	16 (HMB-6 only)
UNDRAINED PROPERTIES *			
Undrained Cohesion, C_u, psf			
	4-12*	1,000	--
	12-16*	2,500	--
	16-18*	2,400	--
	18-23*	2,200	--
	23-28*	2,500	--
	28-30*	800	--
Angle of Internal, ϕ, degrees			
	4-12*	--	28 (HMB-1 only)
	12-16*	--	30 (HMB-1 and HMB-7 only)
	16-18*	--	30(HMB-1, HMB-6 and HMB-7 only)
	18-23*	--	30 (HMB-5, HMB-7 and HMB-8)
	23-28*	--	28 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30*	--	30 (HMB-6 only)
Elastic Modulus, E, psf	4-12*	300,000	210,000 (HMB-1 only)
	12-16*	750,000	140,000 (HMB-1 and HMB-7 only)
	16-18*	720,000	210,000(HMB-1, HMB-6 and HMB-7 only)
	18-23*	660,000	378,000(HMB-5, HMB-7 and HMB-8)
	23-28*	750,000	128,000(HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30*	240,000	238,000(HMB-6 only)
Coefficient of Lateral Earth Pressure at Rest, K	4-12*	1.2	0.5 (HMB-1 only)
	12-16*	1.2	0.5 (HMB-1 and HMB-7 only)
	16-18*	1.2	0.5(HMB-1, HMB-6 and HMB-7 only)
	18-23*	1.2	0.5 (HMB-5, HMB-7 and HMB-8)
	23-28*	1.2	0.5 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30*	1.2	0.5 (HMB-6 only)
Poisson's Ratio		0.45	0.3

TABLE 3.2
GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION HARVEST MOON LIFT STATION
(HMB-1 through HMB-8)

PROPERTY		COHESIVE SOILS [1]	COHESIONLESS SOILS [2]
DRAINED PROPERTIES *			
Drained Cohesion, C′, psf			
	4-12*	0	--
	12-16*	0	--
	16-18*	0	--
	18-23*	0	--
	23-28*	0	--
	28-30*	0	--
Angle of Internal Friction, ϕ', degrees			
	4-12*	18	28 (HMB-1 only)
	12-16*	18	30 (HMB-1 and HMB-7 only)
	16-18*	25	30(HMB-1, HMB-6 and HMB-7 only)
	18-23*	27	30 (HMB-5, HMB-7 and HMB-8)
	23-28*	25	28 (HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30*	22	30 (HMB-6 only)
Elastic Modulus, E, psf			
	4-12*	180,000	210,000 (HMB-1 only)
	12-16*	450,000	140,000 (HMB-1 and HMB-7 only)
	16-18*	432,000	210,000(HMB-1, HMB-6 and HMB-7 only)
	18-23*	396,000	378,000(HMB-5, HMB-7 and HMB-8)
	23-28*	450,000	128,000(HMB-4, HMB-5, HMB-6, HMB-7 and HMB-8)
	28-30*	144,000	238,000(HMB-6 only)

Notes:
1. Cohesive soils include Fat clay, lean clay and sandy lean clay.
2. Cohesionless soils include silty sand, sandy silt, silt and clayey sand.

* Within tunneling zone (one bore diameter, but not less than 6 feet, above and below tunnel bore).

APPENDIX A

LOG OF BORING NO. NBB-1

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13798493.12, E 3072320.36 Northbrook LS; See Plan of Borings (Figure 2.1)

COMPLETION DEPTH : 15.0 FT.

SURFACE ELEVATION : 62.94 FT.

DATE : 06-25-13

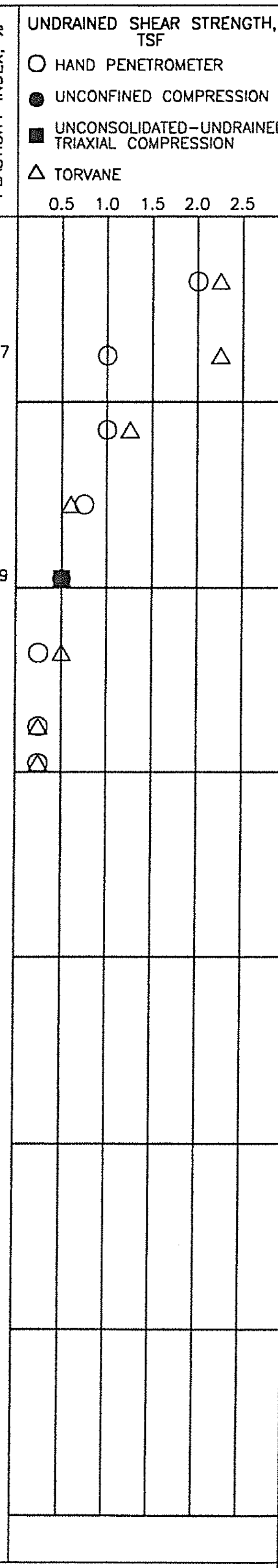
SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 15.0 FT.

WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
62.9	0	3" Asphalt over 6" Sand and Shell Base
62.2		FILL: hard gray and brown fat clay -very stiff to hard w/calcareous nodules 2'-4' -w/ferrous nodules and ferrous stains 2'-15' -very stiff 4'-6' -stiff 6'-10' -medium stiff to stiff 10'-12' -medium stiff 12'-15'
47.9	15	

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			14			
			20	61	24	37
			18			
			27			
	86	96	28	56	27	29
			28			
			28			
			31			



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 15.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-1

LOG OF BORING NO. HTB-1

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13874905.54, E 3122565.57 Hardy Temp LS; See Plan of Borings (Figure 2.2)

COMPLETION DEPTH : 16.0 FT.

SURFACE ELEVATION : 66.89 FT.

DATE : 06-25-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 10.0 FT.

WET ROTARY : 10.0 TO 16.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: O HAND PENETROMETER; ● UNCONFINED COMPRESSION; ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION; △ TORVANE (scale 0.5 1.0 1.5 2.0 2.5)

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
66.9	0	FILL: dark gray sandy lean clay -w/roots 0'-1' -w/gravel 0'-4' -medium stiff to stiff gray 1'-2' -yellowish brown and gray 2'-4'				16			
62.9	5					17			
		Very stiff yellowish brown and gray SANDY LEAN CLAY (CL) w/sand seams -stiff to very stiff 6'-8'		59	115	16	37	16	21
58.9	10	Medium dense gray SILTY SAND (SM)	12			15			
			12	18		20			
			19			21			
50.9	15		23			20			

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 10.0 FT. DURING DRILLING; AFTER 10.0 MIN. AT 8.0 FT.
HOLE OPEN TO 16.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-2

LOG OF BORING NO. HTB-2

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13875146.32, E 3122915.13 Hardy Temp LS; See Plan of Borings (Figure 2.2)

COMPLETION DEPTH : 20.0 FT.

SURFACE ELEVATION : 67.42 FT.

DATE : 06-25-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 12.0 FT.

WET ROTARY : 12.0 TO 20.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
67.4	0	Very stiff gray and brown SANDY LEAN CLAY (CL) w/ferrous stains -w/sand and shell 0'-14" -w/calcareous nodules 14"-4' -stiff to very stiff 2'-4' -stiff 4'-8'				14			
						14			
	5	-w/ferrous nodules 6'-10'			114	14	30	16	14
		-stiff to very stiff 8'-10'				15			
	10	-medium stiff to very stiff 10'-12'				14			
55.4					120	15			
		Medium dense brown SILTY SAND (SM)	16	15		22			
51.4	15		22			19			
		Stiff to very stiff gray and brown LEAN CLAY (CL) w/sand seams -very stiff w/clay seams 18'-20'				17			
47.4	20					31			

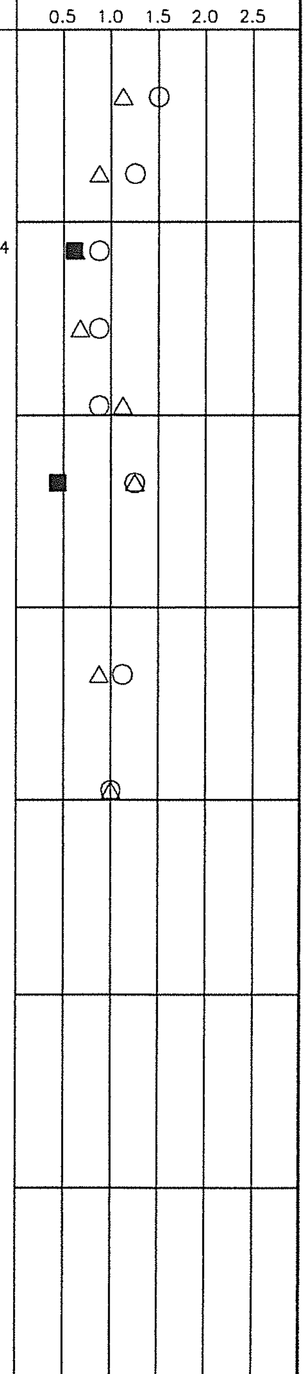
UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER

● UNCONFINED COMPRESSION

■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION

△ TORVANE



DEPTH TO WATER IN BORING :

▽: FREE WATER 1st ENCOUNTERED AT 12.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 8.9 FT.

HOLE OPEN TO 20.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

LOG OF BORING NO. HWB-1

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas
PROJECT NO. : 1140194901

LOCATION : N 13865469.33, E 3171961.95 Hunterwood LS; See Plan of Borings (Figure 2.3)
COMPLETION DEPTH : 52.0 FT.

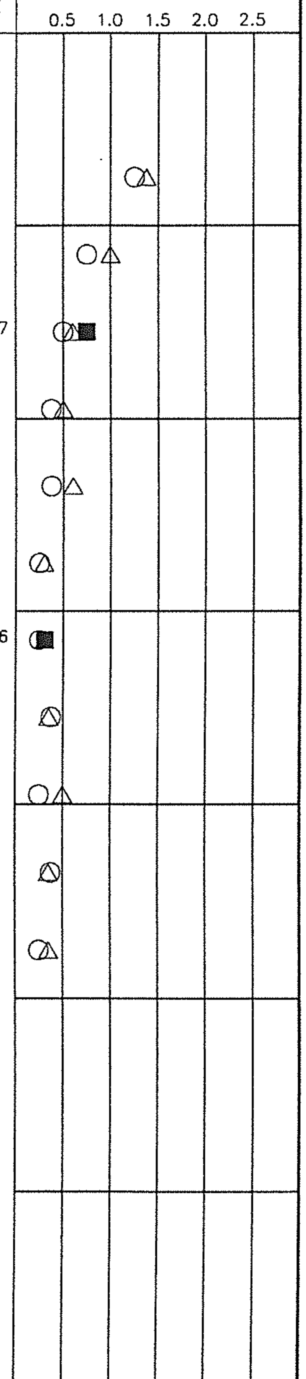
SURFACE ELEVATION : 31.07 FT.
DATE : 06-26-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 24.0 FT.
WET ROTARY : 24.0 TO 52.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
31.1	0	6" Concrete over 6" Stabilized Sand and Shell
30.1		Very stiff gray FAT CLAY (CH) w/sand seams, ferrous nodules and ferrous stains –stiff to very stiff 4'–6' –stiff 6'–8' –medium stiff to stiff 8'–12' –medium stiff 12'–18' –slickensided 14'–16' –medium stiff to stiff 18'–20' –medium stiff 20'–22'
9.1		Medium stiff gray SANDY LEAN CLAY (CL) w/sand seams –clayey sand 24'–26'
5.1		Loose gray SILTY SAND (SM) –medium dense 30'–32' –dense 32'–34'
-2.9		Medium dense gray FINE SAND (SP)
-3.9	35	

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			21			
			23			
			24			
	93	96	25	58	21	37
			34			
			30			
			32			
	86	84	35	58	22	36
			32			
			35			
			34			
			24			
			20			
7	17		21			
8			25			
17			22			
49			21			

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE



DEPTH TO WATER IN BORING :
FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 19.4 FT.
HOLE OPEN TO 52.0 FT. AT END OF DRILLING.

Continued on Figure A-4a

Geotest Engineering, Inc.

LOG OF BORING NO. HWB-1 Cont'd

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13865469.33, E 3171961.95 Hunterwood LS; See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 52.0 FT.

SURFACE ELEVATION : 31.07 FT.

DATE : 06-26-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 24.0 FT.
WET ROTARY : 24.0 TO 52.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: O HAND PENETROMETER; ● UNCONFINED COMPRESSION; ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION; △ TORVANE; 0.5 1.0 1.5 2.0 2.5

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
-3.9	35	Medium dense gray FINE SAND (SP)	27			20			
			26	2		24			
		-dense 38.5'-40'	32			20			
	40		16			23			
-10.9		Medium stiff gray LEAN CLAY (CL) w/sand		74	97	27	40	17	23
-12.9	45	Medium dense gray FINE SAND (SP-SM) w/silt -w/clay seams 46'-52'	26			20			
			19	10		20			
	50		23			19			
-20.9			21			21			
	55								
	60								
	65								
	70								

DEPTH TO WATER IN BORING :
∇: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 19.4 FT.
HOLE OPEN TO 52.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

LOG OF BORING NO. HMB-1 (HMB-1P)

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13841099.04, E 3047437.25
Harvest Moon LS; See Plan of Borings (Figure 2.4)

COMPLETION DEPTH : 70.0 FT.

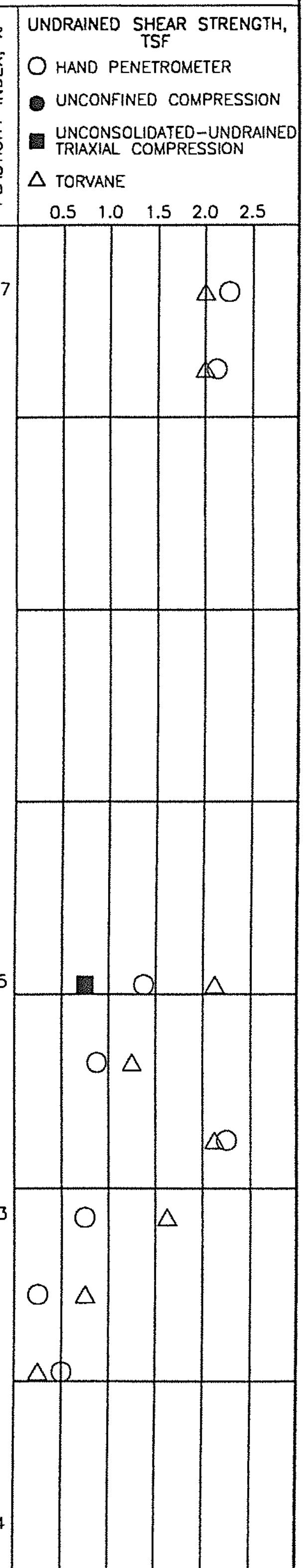
SURFACE ELEVATION : 68.74 FT.

DATE : 06-24-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 32.0 FT.
WET ROTARY : 32.0 TO 70.0 FT.

ELEVATION, FEET	DESCRIPTION OF MATERIAL
68.7 – 68.1	8" Concrete
68.1 – 67.4	8.5" Shell Base
67.4 – 64.7	Hard brown LEAN CLAY (CL) –reddish brown w/shell w/ferrous nodules and ferrous stains 2'–4'
64.7 – 62.2	Medium dense brown SANDY SILT (ML) w/sand and clay seams
62.2 – 51.7	Medium dense brown SILTY SAND (SM) –dense 8.5'–10' –loose 10.5'–12' –loose 14.5'–16'
51.7 – 36.7	Very stiff reddish brown and gray LEAN CLAY (CL) w/sand, ferrous nodules and ferrous stains –w/vertical sand seams 20'–28' –medium stiff to stiff 26'–30'
36.7 – 33.7	Dense gray SILT (ML) w/sand –very dense reddish brown 34.5'–36'

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			8	33	16	17
			22			
16	56		11			
15	44		6			
31			8			
6			12			
13			13			
7			16			
13			20			
	82	113	19	43	18	25
			20			
			21			
	93		24	43	20	23
			21			
			22			
31	76		23			
35	78		22	21	17	4



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 32.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 20.6 FT.
▼: WATER DEPTH AT 18.4 FT., HOLE OPEN TO 50.0 FT. ON 07-24-13.

Continued on Figure A-5a

Geotest Engineering, Inc.

LOG OF BORING NO. HMB-1 (HMB-1P) Cont'd

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13841099.04, E 3047437.25 Harvest Moon LS; See Plan of Borings (Figure 2.4)

COMPLETION DEPTH : 70.0 FT.

SURFACE ELEVATION : 68.74 FT.

DATE : 06-24-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 32.0 FT.

WET ROTARY : 32.0 TO 70.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
33.7	35	Dense gray SILT (ML) w/sand	82/5.0"	73		20			
32.7		Medium stiff to stiff reddish brown and gray SILTY CLAY (CL-ML)		91		22	25	19	6
		-very stiff 38.5'-40'	18			23			
28.7	40	Dense reddish brown and gray SANDY SILT (ML) w/clay seams	33			23			
		-medium dense 42.5'-44'	13	68		23			
	45		34			22			
22.7		Hard reddish brown and gray FAT CLAY (CH) w/ferrous nodules		100	104	23	65	25	40
						25			
	50					28			
						29			
	55	-very stiff to hard 56'-58'				24			
				100	98	28	76	28	48
						25			
	60					29			
6.7		Hard reddish brown LEAN CLAY (CL) w/sand and calcareous nodules			116	16			
	65					16			
						18			
						19			
-1.3	70								

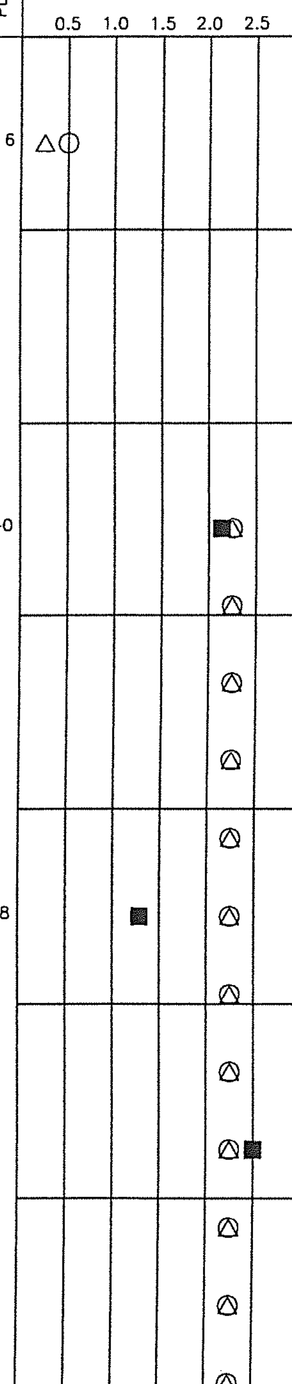
UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER

● UNCONFINED COMPRESSION

■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION

△ TORVANE



DEPTH TO WATER IN BORING :

∇: FREE WATER 1st ENCOUNTERED AT 32.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 20.6 FT.

▼: WATER DEPTH AT 18.4 FT., HOLE OPEN TO 50.0 FT. ON 07-24-13.

Geotest Engineering, Inc.

LOG OF BORING NO. HMB-2

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13841228.95, E 3046737.51 Harvest Moon Ln; See Plan of Borings (Figure 2.5)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 72.98 FT.

DATE : 05-29-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 24.0 FT.
WET ROTARY : 24.0 TO 30.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE
0.5 1.0 1.5 2.0 2.5

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
73.0	0	5.5" Concrete							
72.5		Hard gray FAT CLAY (CH) w/ferrous stains and ferrous nodules				18			
		-very stiff 4'-6'				17			
	5	-very stiff to hard 6'-8'		90	106	21	76	28	48
						23			
65.0		Very stiff to hard brown and gray LEAN CLAY (CL) w/sand		76	120	14	46	19	27
	10	-hard 10'-12'				11			
		-very stiff brown w/silt seams 14'-16'				15			
	15					20			
57.0		Medium stiff reddish brown and gray SANDY LEAN CLAY (CL)		63	108	20	26	18	8
			13	64		20			
	20	-medium stiff to stiff 23'-25'				21			
	25	-very stiff to hard 28'-30'				18			
43.0	30								
	35								

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING;
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-6

LOG OF BORING NO. HMB-3

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13840824.01, E 3046650.89 Harvest Moon Ln; See Plan of Borings (Figure 2.5)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 72.90 FT.

DATE : 05-29-13

SAMPLER : Shelby Tube/Split Spoon

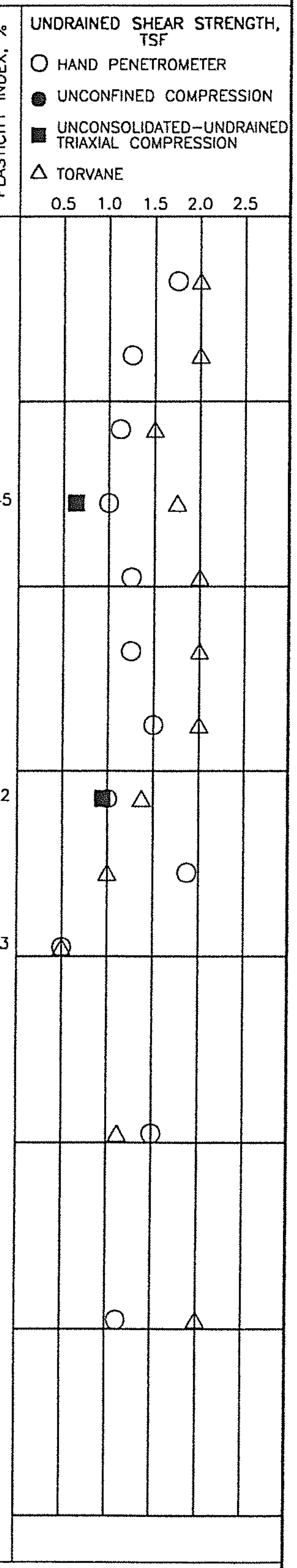
DRY AUGER : 0.0 TO 30.0 FT.

WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
72.9 – 72.2	0	7" Concrete over 2" Brown Sand
72.2 – 64.9		Very stiff to hard gray FAT CLAY (CH) w/sand seams and ferrous stains -w/ferrous nodules 2'-8' -very stiff 4'-6' -w/calcareous nodules 4'-8' -stiff to very stiff 6'-8'
64.9 – 56.9		Very stiff to hard gray and brown FAT CLAY (CH) w/sand, calcareous and ferrous nodules -very stiff 14'-16'
56.9 – 49.9		Very stiff gray SANDY LEAN CLAY (CL) w/ferrous stains -stiff 18'-20'
49.9 – 42.9	–30	Very stiff reddish brown and gray FAT CLAY (CH) w/sand seams and calcareous nodules -hard 28'-30'

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			16			
			21			
			23			
	91	101	24	71	26	45
			24			
			22			
			17			
	80	110	21	51	19	32
			17			
	68		15	28	15	13
			19			
			20			

UNDRAINED SHEAR STRENGTH, TSF



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-7

LOG OF BORING NO. HMB-4

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13840512.58, E 3046175.11 Honeywood Trail; See Plan of Borings (Figure 2.5)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 76.23 FT.

DATE : 05-29-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 24.0 FT.

WET ROTARY : 24.0 TO 30.0 FT.

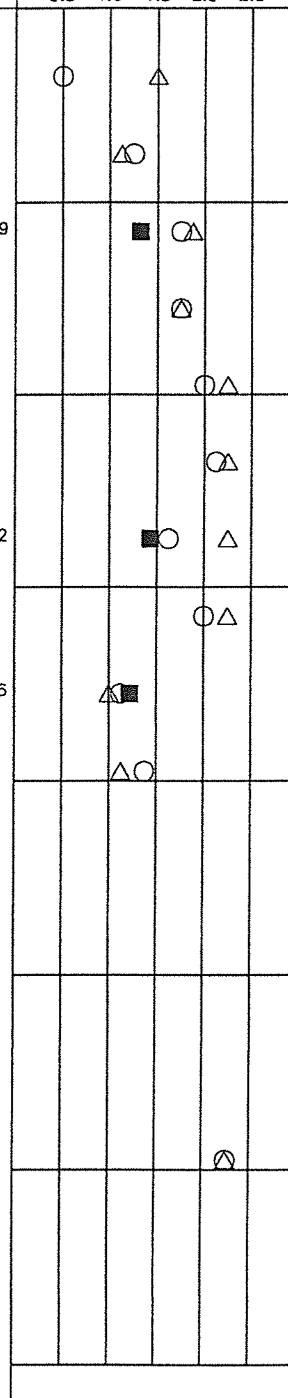
ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
76.2 – 75.6	0	6" Concrete over 2" Brown Sand
75.6 – 64.2		Stiff to very stiff dark gray FAT CLAY (CH) w/sand, ferrous nodules and ferrous stains -very stiff 2'-8' -gray and brown 2'-12' -w/calcareous nodules 4'-12' -hard 8'-12'
64.2 – 60.2		Very stiff to hard gray and reddish brown FAT CLAY (CH) w/sand seams and calcareous and ferrous nodules -slickensided 12'-14' -hard 14'-16'
60.2 – 53.2		Very stiff gray and reddish brown LEAN CLAY (CL) w/calcareous nodules and ferrous stains
53.2 – 48.2		Loose reddish brown SILT (ML) w/clay stone
48.2 – 46.2	30	Hard reddish brown FAT CLAY (CH) w/silt seams and ferrous stains

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			23			
			19			
	81	114	17	63	24	39
			16			
			16			
			18			
	93	114	18	68	26	42
			20			
	91	115	20	45	19	26
			22			
9	91		26			
			26			

UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

0.5 1.0 1.5 2.0 2.5



DEPTH TO WATER IN BORING :
∇: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 10.0 MIN. AT 19.5 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-8

LOG OF BORING NO. HMB-5

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13840507.84, E 3045799.83 Honeywood Trail; See Plan of Borings (Figure 2.6)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 74.61 FT.

DATE : 05-29-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 24.0 FT.

WET ROTARY : 24.0 TO 30.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
74.6 – 73.9	0	6" Concrete over 2" Brown Sand and Clay Mix
73.9 – 58.6		Hard dark gray FAT CLAY (CH) w/calcareous and ferrous nodules and ferrous stains –gray and brown 4'–14' –very stiff reddish brown 14'–16'
58.6 – 56.6		Medium stiff to stiff gray and reddish brown LEAN CLAY (CL)
56.6 – 46.6		Medium dense reddish brown SANDY SILT (ML) w/clay seams
46.6 – 44.6	30	Stiff to very stiff reddish brown FAT CLAY (CH)

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
			16			
			16			
			15			
	86	115	14	53	20	33
			18			
			17			
			17			
			22			
	97	106	24	36	17	19
25			20			
22	69		23			
13			26			
			24			

UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 18.5 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-9

LOG OF BORING NO. HMB-6

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13840420.64, E 3045450.61 Dairy Ashford Rd; See Plan of Borings (Figure 2.6)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 75.05 FT.

DATE : 05-30-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 22.0 FT.
WET ROTARY : 22.0 TO 30.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; ● UNCONFINED COMPRESSION; ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION; △ TORVANE (scale 0.5 1.0 1.5 2.0 2.5)

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
75.1	0	7.5" Concrete							
74.4		FILL: brown and gray sand w/gravel				20			
		-w/calcareous and ferrous nodules 1'-10'				18			
	5	-very stiff gray sandy lean clay 4'-6'				25			
		-medium stiff to stiff yellow and gray sandy lean clay 6'-8'				19			
67.1		Stiff to very stiff gray and reddish brown FAT CLAY (CH) w/sand seams, calcareous nodules and ferrous stains		88	106	22	67	25	42
	10	-very stiff 10'-12'				23			
		-stiff to hard, slickensided 14'-16'				21			
	15			96	96	28	58	23	35
59.1		Brown and gray CLAYEY SAND (SC)				30			
57.1		Stiff to hard reddish brown LEAN CLAY (CL) w/calcareous nodules and ferrous stains		98	117	19	29	19	10
	20								
52.1		Medium dense to dense reddish brown SILTY SAND (SM)	31	46		23			
	25	-w/clayey silt 28.5'-30'							
45.1	30		17			16			
	35								

DEPTH TO WATER IN BORING :
∇: FREE WATER 1st ENCOUNTERED AT 22.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 19.8 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-10

LOG OF BORING NO. HMB-7 (HMB-7P)

PROJECT : FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13840919.65, E 3045429.02 Dairy Ashford Rd; See Plan of Borings (Figure 2.6)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 73.12 FT.

DATE : 05-30-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 20.0 FT.

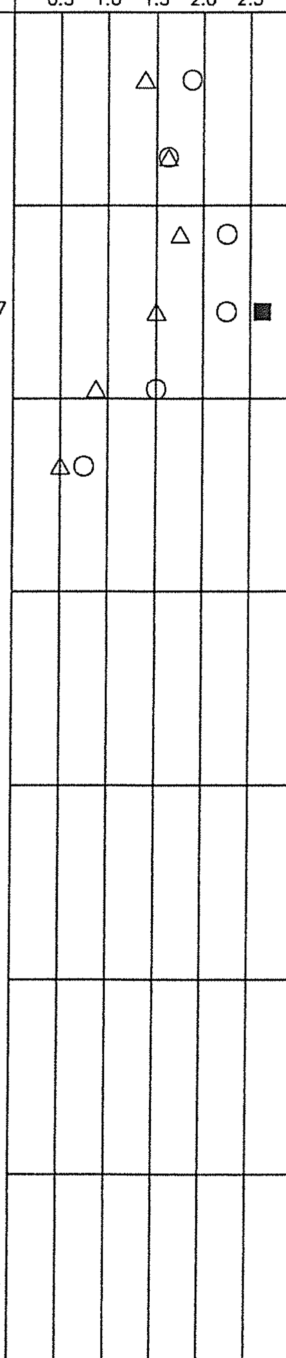
WET ROTARY : 20.0 TO 30.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL
73.1 – 72.5	0	7.5" Concrete
72.5 – 61.1		Very stiff yellow, reddish brown and gray SANDY LEAN CLAY (CL) -gray 2'-4' -w/ferrous nodules 2'-8' -very stiff to hard 4'-8' -stiff to very stiff 8'-10' -very sandy clay 8'-12' -stiff w/clayey sand layer 10'-12'
61.1 – 50.1		Medium dense gray and reddish brown SILTY SAND (SM) -dense 16'-18' -gray and brown 16'-23' -very dense 18'-20'
50.1 – 45.1		Medium dense reddish brown SANDY SILT (ML) -w/clay seams and clay stone 23.5'-25'
45.1 – 43.1	30	Very stiff reddish brown FAT CLAY (CH) w/silt seams, calcareous and ferrous nodules

Sample (approx. depth, ft)	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
1.5				13			
3.5				15			
5.5				14			
7.5		70	118	11	32	15	17
9.5				13			
11.5				13			
13.5	23			17			
15.5	27			20			
17.5	41	29		20			
19.5	90/11.0"			19			
24.5	16			24			
29.5	22	100		24	61	24	37

UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE



DEPTH TO WATER IN BORING :

∇: FREE WATER 1st ENCOUNTERED AT 20.0 FT. DURING DRILLING; AFTER 10.0 MIN. AT 17.0 FT.

▼: WATER DEPTH AT 16.0 FT., HOLE OPEN TO 30.0 FT. ON 07-02-13.

Geotest Engineering, Inc.

FIGURE A-11

LOG OF BORING NO. HMB-8

PROJECT : FY2012 Lift Station Renewol/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R–000267–0111–3; City of Pearland, Texas

PROJECT NO. : 1140194901

LOCATION : N 13841367.34, E 3045404.05 Dairy Ashford Rd; See Plan of Borings (Figure 2.6)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 73.55 FT.

DATE : 05–30–13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 24.0 FT.
WET ROTARY : 24.0 TO 30.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; ● UNCONFINED COMPRESSION; ■ UNCONSOLIDATED–UNDRAINED TRIAXIAL COMPRESSION; △ TORVANE (scale 0.5 1.0 1.5 2.0 2.5)

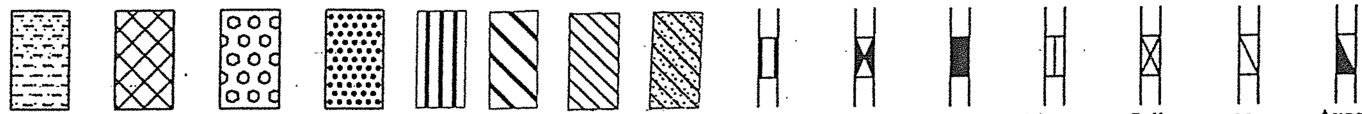
ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
73.6	0	7.5" Concrete							
72.9		Very stiff gray LEAN CLAY (CL) w/sand, calcareous nodules and ferrous stains				20			
		–gray and brown 4'–6'				16			
	5	–hard 6'–8'				17			
		–stiff to very stiff w/ferrous nodules 8'–12'				16			
	10	–very sandy clay 10'–16'		77	114	18	32	15	17
						17			
		–stiff 14'–16'				14			
	15					22			
57.6		Very stiff reddish brown LEAN CLAY (CL) w/ferrous nodules		92		19	26	17	9
55.6		Medium dense reddish brown SANDY SILT (ML) w/clay seams	12			18			
	20								
		–brown and gray 23'–25'							
	25		12	53		25			
45.6		Reddish brown LEAN CLAY (CL)	30			22			
43.6	30								
	35								

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 10.0 MIN. AT 17.8 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES (SHOWN IN SYMBOL COLUMN) — **SAMPLER TYPES** (SHOWN IN SAMPLES COLUMN)



Asphaltic Concrete | Fill | Gravel | Sand | SILT | CLAY | LEAN CLAY | Sandy LEAN CLAY | Pitcher Barrel | Nx Core | Shelby Tube | Piston | Split Spoon | No Recovery | Auger

Predominant type shown heavy

TERMS DESCRIBING CONSISTENCY OR CONDITION

Basic Soil Type	Density or Consistency	Standard Penetration Resistance, (1) Blows/ft.	Unconfined Compressive Strength (q_u), (2) Tons/sq. ft.
Cohesionless	Very loose	Less than 4	Not applicable
	Loose	4 to <10	Not applicable
	Medium dense	10 to <30	Not applicable
	Dense	30 to <50	Not applicable
	Very dense	50 or greater	Not applicable
Cohesive	Very soft	Less than 2	Less than 0.25
	Soft	2 to <4	0.25 to <0.5
	Firm/Medium stiff	4 to <8	0.5 to <1.0
	Stiff	8 to <15	1.0 to <2.0
	Very stiff	15 to <30	2.0 to <4.0
	Hard	30 or greater	4 or greater

(1) Number of blows from 140-lb. weight falling 30-in. to drive 2-in. OD, 1-3/8-in. ID, split barrel sampler (ASTM D1586)

(2) q_u may also be approximated using a pocket penetrometer

TERMS CHARACTERIZING SOIL STRUCTURE

Parting: -paper thin in size   Seam: -1/8" to 3" thick   Layer: -greater than 3"

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying color and texture.
Interbedded	- composed of alternate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well graded	- having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.
Flocculated	- pertaining to cohesive soils that exhibit a loose knit or flakey structure.

Job No. 1140194901

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: FY 12 LIFT STATION RENEWAL AND REPLACEMENT HARVEST MOON LIFT STATION, WBS NO. R-000267-0111-3		PIEZOMETER NUMBER: HMB-1P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT ARCADIS US	HOUSTON, TEXAS

COMPLETION DATE 6-24-13

DRY AUGERED 0 TO 32.0 FT

WASH BORED 32.0 TO 70.0 FT

DRILLING FLUID: WATER

DEVELOPMENT DATE: 6-24-13

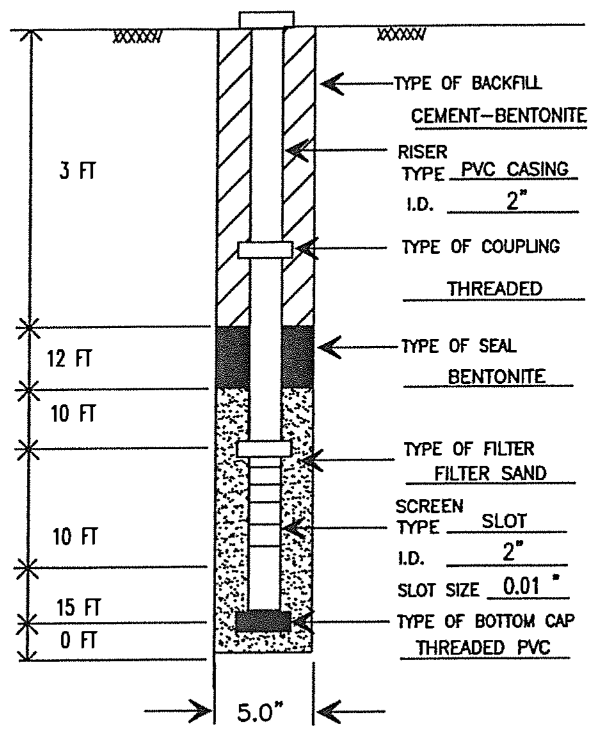
METHOD OF DEVELOPMENT:

BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
6-25-13	14.1	54.64
7-24-13	18.4	50.34

DEPTH (FT)	ELEV. (FT)
0	68.74
3	65.74
15	53.74
25	43.74
35	33.74
50	18.74
50	18.74



(NOT TO SCALE)

REMARKS:

NOTES: 1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED 2. TOG = TOP OF GROUND	DRILLED BY: DG	STARTED: 6-24-13	NORTHING: 13841099.04 EASTING: 3047437.25
	LOGGED BY: TM	COMPLETED: 6-24-13	GROUND LEVEL (MSL): 68.74 FT
	CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

Job No. 1140194901

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: FY 12 LIFT STATION RENEWAL AND REPLACEMENT HARVEST MOON LIFT STATION, WBS NO. R-000267-0111-3		PIEZOMETER NUMBER: HMB-7P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT ARCADIS, US	HOUSTON, TEXAS

COMPLETION DATE 5-30-13

DRY AUGERED 0 TO 20 FT

WASH BORED 20 TO 30 FT

DRILLING FLUID: WATER

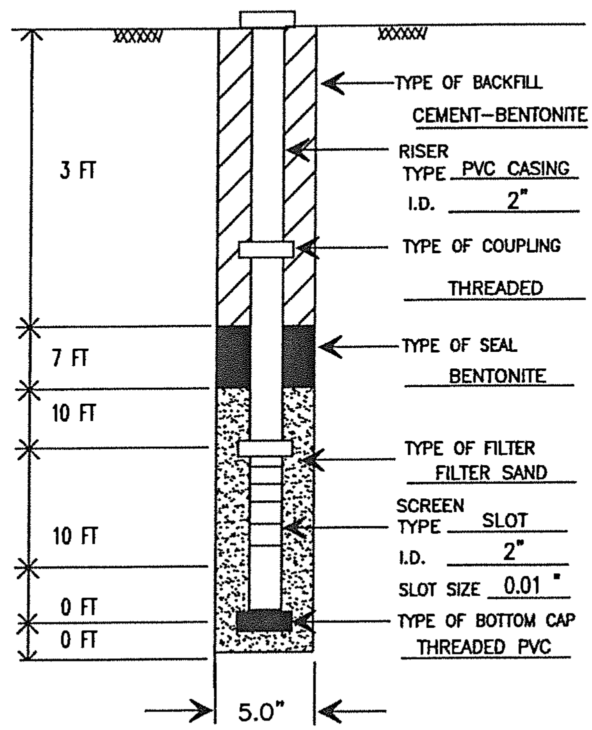
DEVELOPMENT DATE: 5-30-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
5-31-13	16.0	57.12
7-2-13	16.0	57.12

DEPTH (FT)	ELEV. (FT)
0	73.12
3	70.12
10	63.12
20	53.12
30	43.12
30	43.12
30	43.12



(NOT TO SCALE)

REMARKS:

NOTES:

1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: DG	STARTED: 5-30-13	NORTHING: 13840919.65 EASTING: 3045429.02
LOGGED BY: TM	COMPLETED: 5-30-13	GROUND LEVEL (MSL): 73.12 FT
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
NBB-1	2	0.8	2.0	UD		14									2.25	2.00	Fill
	3	2.0	4.0	UD		20		61	24	37					2.25	1.00	Fill
	4	4.0	6.0	UD		18									1.25	1.00	Fill
	5	6.0	8.0	UD		27									0.60	0.75	Fill
	6	8.0	10.0	UD		28	96	56	27	29	86		0.50	0.72	0.50	0.50	Fill
	7	10.0	12.0	UD		28									0.50	0.25	Fill
	8	12.0	14.0	UD		28									0.25	0.25	Fill
	9	14.0	15.0	UD		31									0.25	0.25	Fill

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-1

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
HTB-1	2	1.0	2.0	UD		16									0.40	0.50	Fill
	4	4.0	6.0	UD		17									1.13	1.63	Sandy Lean Clay
	5	6.0	8.0	UD		16	115	37	16	21	59		0.59	0.58	1.00	1.38	Sandy Lean Clay
	6	8.5	10.0	SS	12	15											Silty Sand
	7	10.5	12.0	SS	12	20					18						Silty Sand
	8	12.5	14.0	SS	19	21											Silty Sand
	9	14.5	16.0	SS	23	20											Silty Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-2

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R–000267–0111–3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U–U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U–U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE–TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HTB–2	2	1.2	2.0	UD		14									1.13	1.50	Sandy Lean Clay
	3	2.0	4.0	UD		14									0.88	1.25	Sandy Leon Clay
	4	4.0	6.0	UD		14	114	30	16	14			0.61	0.43	0.63	0.88	Sandy Lean Clay
	5	6.0	8.0	UD		15									0.68	0.88	Sandy Lean Clay
	6	8.0	10.0	UD		14									1.13	0.88	Sandy Lean Clay
	7	10.0	12.0	UD		15	120						0.44	0.86	1.25	1.25	Sandy Lean Clay
	8	12.5	14.0	SS	16	22					15						Silty Sand
	9	14.5	16.0	SS	22	19											Silty Sond
	10	16.0	17.0	UD		17									0.88	1.13	Leon Clay
	11	18.0	20.0	UD		31									1.00	1.00	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx–DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B–3

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	Depth (ft.) Top	Depth (ft.) Bottom	Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	PL	PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HWB-1	2	1.0	2.0	UD		21											Fat Clay
	3	2.0	4.0	UD		23									1.38	1.25	Fat Clay
	4	4.0	6.0	UD		24									1.00	0.75	Fat Clay
	5	6.0	8.0	UD		25	96	58	21	37	93		0.75	0.58	0.60	0.50	Fat Clay
	6	8.0	10.0	UD		34									0.50	0.38	Fat Clay
	7	10.0	12.0	UD		30									0.60	0.38	Fat Clay
	8	12.0	14.0	UD		32									0.30	0.25	Fat Clay
	9	14.0	16.0	UD		35	84	58	22	36	86		0.31	1.15	0.30	0.25	Fat Clay
	10	16.0	18.0	UD		32									0.35	0.38	Fat Clay
	11	18.0	20.0	UD		35									0.50	0.25	Fat Clay
	12	20.0	22.0	UD		34									0.35	0.38	Fat Clay
	13	22.0	24.0	UD		24									0.35	0.25	Sandy Lean Clay
	14	24.0	26.0	UD		20											Sandy Lean Clay
	15	26.5	28.0	SS	7	21					17						Silty Sand
	16	28.5	30.0	SS	8	25											Silty Sand
	17	30.5	32.0	SS	17	22											Silty Sand
	18	32.5	34.0	SS	49	21											Silty Sand
	19	34.5	36.0	SS	27	20											Sand
	20	36.5	38.0	SS	26	24					2						Sand
	21	38.5	40.0	SS	32	20											Sand
	22	40.5	42.0	SS	16	23											Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-4

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R–000267–0111–3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U–U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U–U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE–TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HWB–1	23	42.0	44.0	UD		27	97	40	17	23	74		0.35	3.17	0.25	0.25	Leon Clay
	24	44.5	46.0	SS	26	20											Sand
	25	46.5	48.0	SS	19	20					10						Sand
	26	48.5	50.0	SS	23	19											Sand
	27	50.5	52.0	SS	21	21											Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx–DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B–4a

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
HMB-1 (HMB-1P)	2	1.4	2.0	UD		8		33	16	17					2.00	2.25	Lean Clay
	3	2.0	4.0	UD		22									2.00	2.13	Lean Clay
	4	4.5	6.0	SS	16	11					56						Sandy Silt
	5	6.5	8.0	SS	15	6					44						Silty Sand
	6	8.5	10.0	SS	31	8											Silty Sand
	7	10.5	12.0	SS	6	12											Silty Sand
	8	12.5	14.0	SS	13	13											Silty Sand
	9	14.5	16.0	SS	7	16											Silty Sand
	10	16.5	18.0	SS	13	20											Lean Clay
	11	18.0	20.0	UD		19	113	43	18	25	82		0.75	1.44	2.13	1.38	Lean Clay
	12	20.0	22.0	UD		20									1.25	0.88	Lean Clay
	13	22.0	24.0	UD		21									2.13	2.25	Lean Clay
	14	24.0	26.0	UD		24		43	20	23	93				1.63	0.75	Lean Clay
	15	26.0	28.0	UD		21									0.75	0.25	Lean Clay
	16	28.0	30.0	UD		22									0.25	0.50	Lean Clay
	17	30.5	32.0	SS	31	23					76						Lean Clay
	18	32.5	34.0	SS	35	22		21	17	4	78						Silt
	19	34.5	36.0	SS	82/5.0"	20					73						Silt
	20	36.0	38.0	UD		22		25	19	6	91				0.25	0.50	Silty Clay
	21	38.5	40.0	SS	18	23											Silty Clay
	22	40.5	42.0	SS	33	23											Sandy Silt

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-5

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-1 (HMB-1P)	23	42.5	44.0	SS	13	23					68						Sandy Silt
	24	44.5	46.0	SS	34	22											Sandy Silt
	25	46.0	48.0	UD		23	104	65	25	40	100		2.14	3.46	2.25	2.25	Fat Clay
	26	48.0	50.0	UD		25									2.25	2.25	Fat Clay
	27	50.0	52.0	UD		28									2.25	2.25	Fat Clay
	28	52.0	54.0	UD		29									2.25	2.25	Fat Clay
	29	54.0	56.0	UD		24									2.25	2.25	Fat Clay
	30	56.0	58.0	UD		28	98	76	28	48	100		1.29	4.18	2.25	2.25	Fat Clay
	31	58.0	60.0	UD		25									2.25	2.25	Fat Clay
	32	60.0	62.0	UD		29									2.25	2.25	Fat Clay
	33	62.0	64.0	UD		16	116						2.50	4.61	2.25	2.25	Lean Clay
	34	64.0	66.0	UD		16									2.25	2.25	Lean Clay
	35	66.0	68.0	UD		18									2.25	2.25	Lean Clay
	36	68.0	70.0	UD		19									2.25	2.25	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-5a

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	Depth (ft.) Top	Depth (ft.) Bottom	Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	PL	PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-2	2	0.5	2.0	UD		18									2.25	2.25	Fat Clay
	3	2.0	4.0	UD		17									2.25	2.25	Fat Clay
	4	4.0	6.0	UD		21	106	76	28	48	90		1.53	0.43	2.25	1.75	Fat Clay
	5	6.0	8.0	UD		23									2.00	1.25	Fat Clay
	6	8.0	10.0	UD		14	120	46	19	27	76		1.66	0.72	2.25	1.75	Lean Clay
	7	10.0	12.0	UD		11									2.25	2.25	Lean Clay
	8	12.0	14.0	UD		15									1.63	2.25	Lean Clay
	9	14.0	16.0	UD		20									1.50	1.63	Lean Clay
	10	16.0	18.0	UD		20	108	26	18	8	63		0.34	1.30	0.20	0.63	Sandy Lean Clay
	11	18.5	20.0	SS	13	20					64						Sandy Lean Clay
	12	23.0	25.0	UD		21									0.20	0.50	Sandy Lean Clay
	13	28.0	30.0	UD		18									1.75	2.25	Sandy Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-6

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	Depth (ft.) Top	Depth (ft.) Bottom	Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	PL	PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-3	2	0.9	2.0	UD		16									2.00	1.75	Fat Clay
	3	2.0	4.0	UD		21									2.00	1.25	Fat Clay
	4	4.0	6.0	UD		23									1.50	1.13	Fat Clay
	5	6.0	8.0	UD		24	101	71	26	45	91		0.64	0.58	1.75	1.00	Fat Clay
	6	8.0	10.0	UD		24									2.00	1.25	Fat Clay
	7	10.0	12.0	UD		22									2.00	1.25	Fat Clay
	8	12.0	14.0	UD		17									2.00	1.50	Fat Clay
	9	14.0	16.0	UD		21	110	51	19	32	80		0.95	1.15	1.38	1.00	Fat Clay
	10	16.0	18.0	UD		17									1.00	1.88	Sandy Lean Clay
	11	18.0	20.0	UD		15		28	15	13	68				0.50	0.50	Sandy Lean Clay
	12	23.0	25.0	UD		19									1.13	1.50	Fat Clay
	13	28.0	30.0	UD		20									2.00	1.13	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-7

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-4	2	0.7	2.0	UD		23									1.50	0.50	Fat Clay
	3	2.0	4.0	UD		19									1.13	1.25	Fat Clay
	4	4.0	6.0	UD		17	114	63	24	39	81		1.32	0.43	1.88	1.75	Fat Clay
	5	6.0	8.0	UD		16									1.75	1.75	Fat Clay
	6	8.0	10.0	UD		16									2.25	2.00	Fat Clay
	7	10.0	12.0	UD		18									2.25	2.13	Fat Clay
	8	12.0	14.0	UD		18	114	68	26	42	93		1.43	1.01	2.25	1.63	Fat Clay
	9	14.0	16.0	UD		20									2.25	2.00	Fat Clay
	10	16.0	18.0	UD		20	115	45	19	26	91		1.22	1.30	1.00	1.13	Lean Clay
	11	18.0	20.0	UD		22									1.13	1.38	Lean Clay
	12	23.5	25.0	SS	9	26					91						Silt
	13	28.0	30.0	UD		26									2.25	2.25	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-8

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	Depth (ft.) Top	Depth (ft.) Bottom	Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	PL	PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-5	2	0.7	2.0	UD		16									2.25	2.25	Fat Clay
	3	2.0	4.0	UD		16									2.25	2.25	Fat Clay
	4	4.0	6.0	UD		15									2.25	2.25	Fat Clay
	5	6.0	8.0	UD		14	115	53	20	33	86		2.88	0.58	2.25	2.25	Fat Clay
	6	8.0	10.0	UD		18									2.25	2.25	Fat Clay
	7	10.0	12.0	UD		17									2.25	2.25	Fat Clay
	8	12.0	14.0	UD		17									2.25	2.25	Fat Clay
	9	14.0	16.0	UD		22									1.25	1.25	Fat Clay
	10	16.0	18.0	UD		24	106	36	17	19	97		0.47	1.30	0.30	0.63	Lean Clay
	11	18.5	20.0	SS	25	20											Sandy Silt
	12	20.5	22.0	SS	22	23					69						Sandy Silt
	13	22.5	24.0	SS	13	26											Sandy Silt
	14	28.0	30.0	UD		24									0.38	1.00	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-9

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations
WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE No.	Depth (ft.) Top	Depth (ft.) Bottom	Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	PL	PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
HMB-6	2	0.6	2.0	UD		20											Fill
	3	2.0	4.0	UD		18									1.38	1.13	Fill
	4	4.0	6.0	UD		25									0.55	0.25	Fill
	5	6.0	8.0	UD		19									2.00	2.25	Fill
	6	8.0	10.0	UD		22	106	67	25	42	88		0.79	0.72	2.00	1.63	Fat Clay
	7	10.0	12.0	UD		23									1.38	1.63	Fat Clay
	8	12.0	14.0	UD		21									0.63	1.38	Fat Clay
	9	14.0	16.0	UD		28	96	58	23	35	96		0.75	1.15	2.25	1.50	Fat Clay
	10	16.0	18.0	UD		30											Clayey Sand
	11	18.0	20.0	UD		19	117	29	19	10	98		0.87	1.44	1.50	2.25	Lean Clay
	12	23.5	25.0	SS	31	23					46						Silty Sand
	13	28.5	30.0	SS	17	16											Silty Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
HMB-7 (HMB-7P)	2	0.6	2.0	UD		13									1.38	1.88	Sandy Lean Clay
	3	2.0	4.0	UD		15									1.63	1.63	Sandy Lean Clay
	4	4.0	6.0	UD		14									1.75	2.25	Sandy Lean Clay
	5	6.0	8.0	UD		11	118	32	15	17	70		2.63	0.58	1.50	2.25	Sandy Lean Clay
	6	8.0	10.0	UD		13									0.88	1.50	Sandy Lean Clay
	7	10.0	12.0	UD		13									0.50	0.75	Sandy Lean Clay
	8	12.5	14.0	SS	23	17											Silty Sand
	9	14.5	16.0	SS	27	20											Silty Sand
	10	16.5	18.0	SS	41	20					29						Silty Sand
	11	18.5	20.0	SS	90/11.0"	19											Silty Sand
	12	23.5	25.0	SS	16	24											Sandy Silt
	13	28.5	30.0	SS	22	24		61	24	37	100						Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-11

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: FY2012 Lift Station Renewal/Replacement – Northbrook, Hardy Temp, Hunterwood, Harvest Moon Lift Stations WBS No. R-000267-0111-3; City of Pearland, Texas

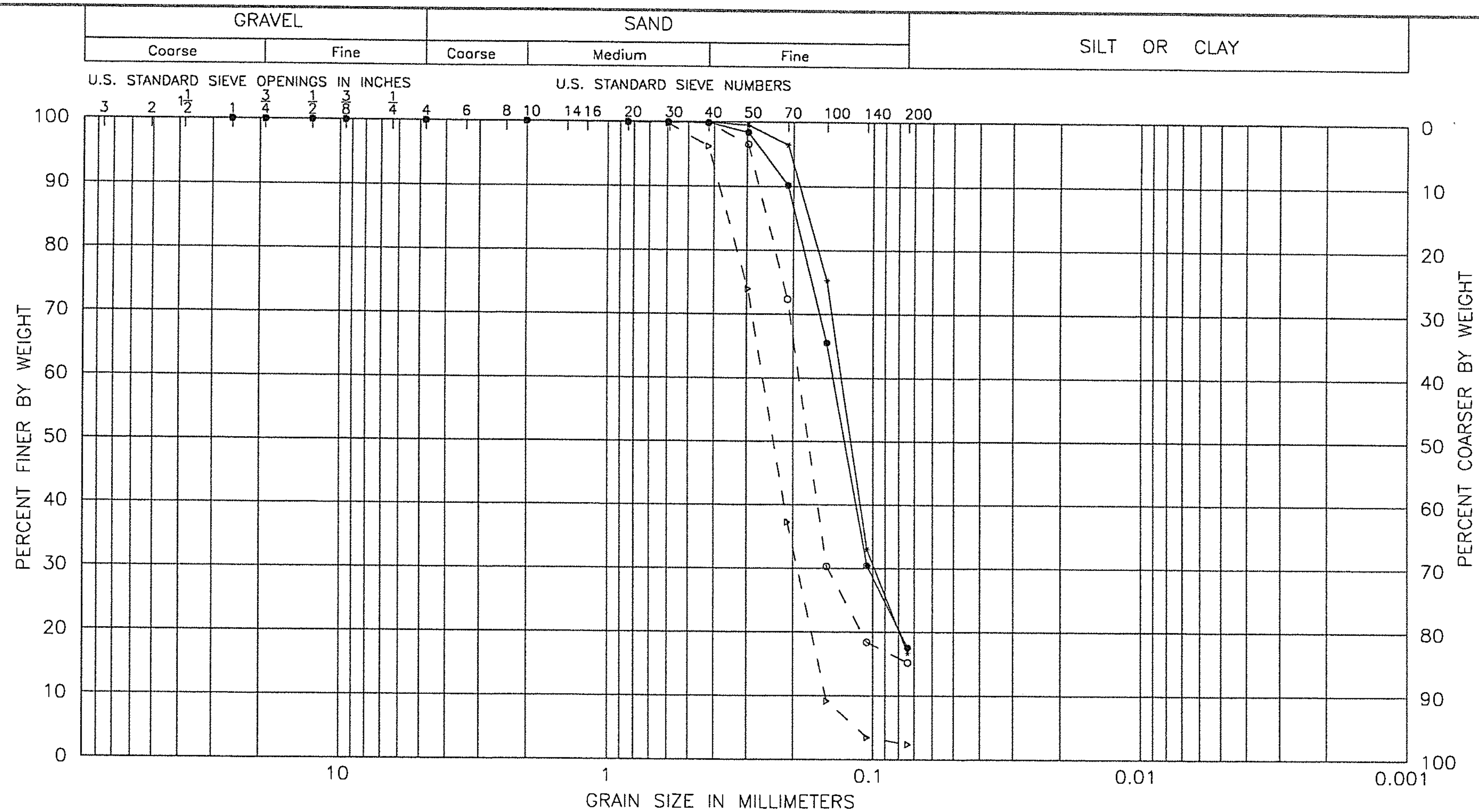
PROJECT NUMBER: 1140194901

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
HMB-8	2	0.6	2.0	UD		20											Lean Clay
	3	2.0	4.0	UD		16									1.25	1.00	Lean Clay
	4	4.0	6.0	UD		17									1.63	1.38	Lean Clay
	5	6.0	8.0	UD		16									2.00	2.00	Lean Clay
	6	8.0	10.0	UD		18	114	32	15	17	77		0.93	0.72	1.25	0.88	Lean Clay
	7	10.0	12.0	UD		17									1.25	0.75	Lean Clay
	8	12.0	14.0	UD		14									1.25	0.25	Lean Clay
	9	14.0	16.0	UD		22									0.50	0.50	Lean Clay
	10	16.0	18.0	UD		19		26	17	9	92				1.50	1.75	Lean Clay
	11	18.5	20.0	SS	12	18											Sandy Silt
	12	23.5	25.0	SS	12	25					53						Sandy Silt
	13	28.5	30.0	SS	30	22											Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

Job No. 1140194901



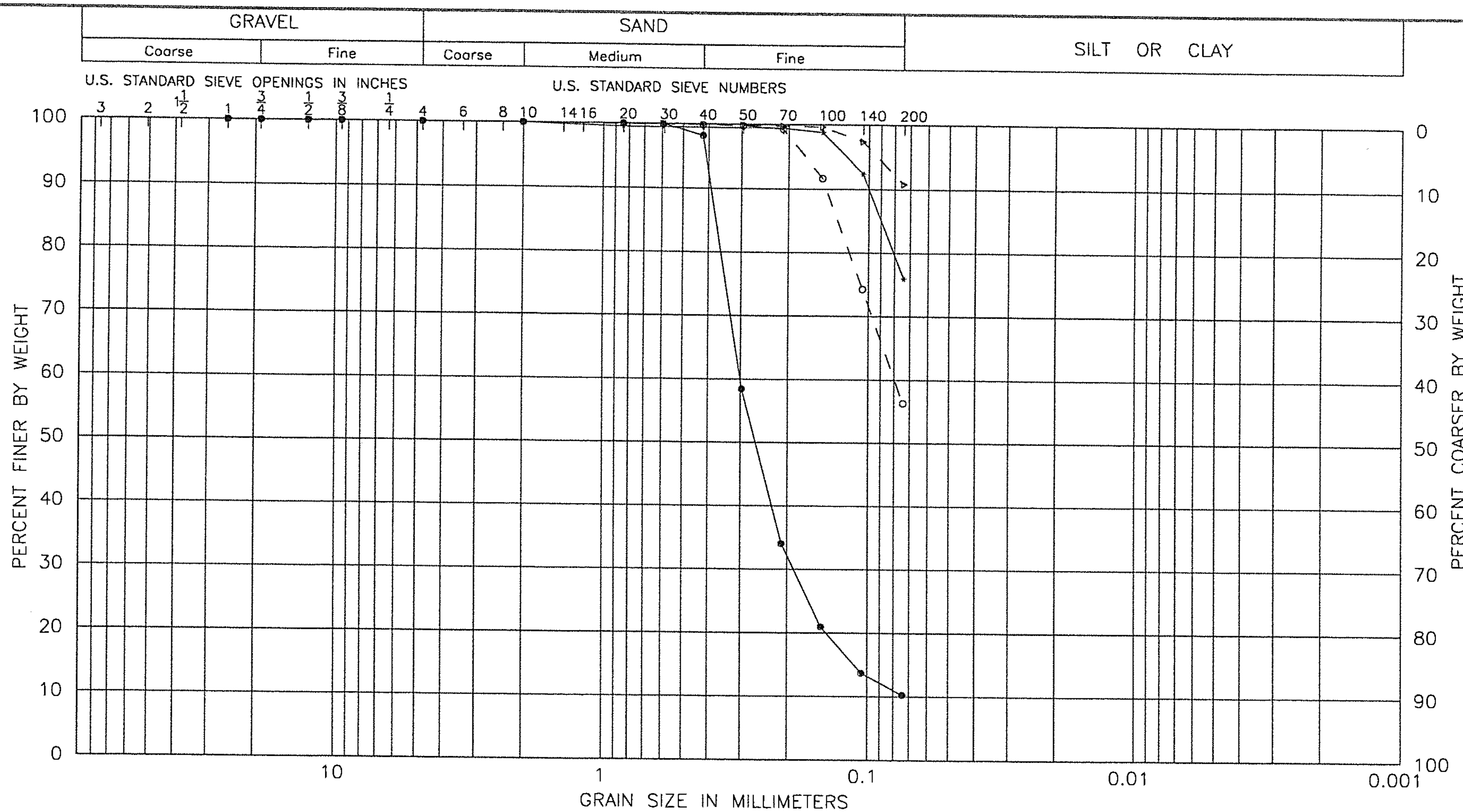
LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●-●-●-●	HTB-1	S-7	10.5-12.0	Gray silty sand
o-o-o-o	HTB-2	S-8	12.5-14.0	Brown silty sand
x-x-x-x	HWB-1	S-15	26.5-28.0	Gray silty sand
▷-▷-▷-▷	HWB-1	S-20	36.5-38.0	Gray fine sand

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B-13

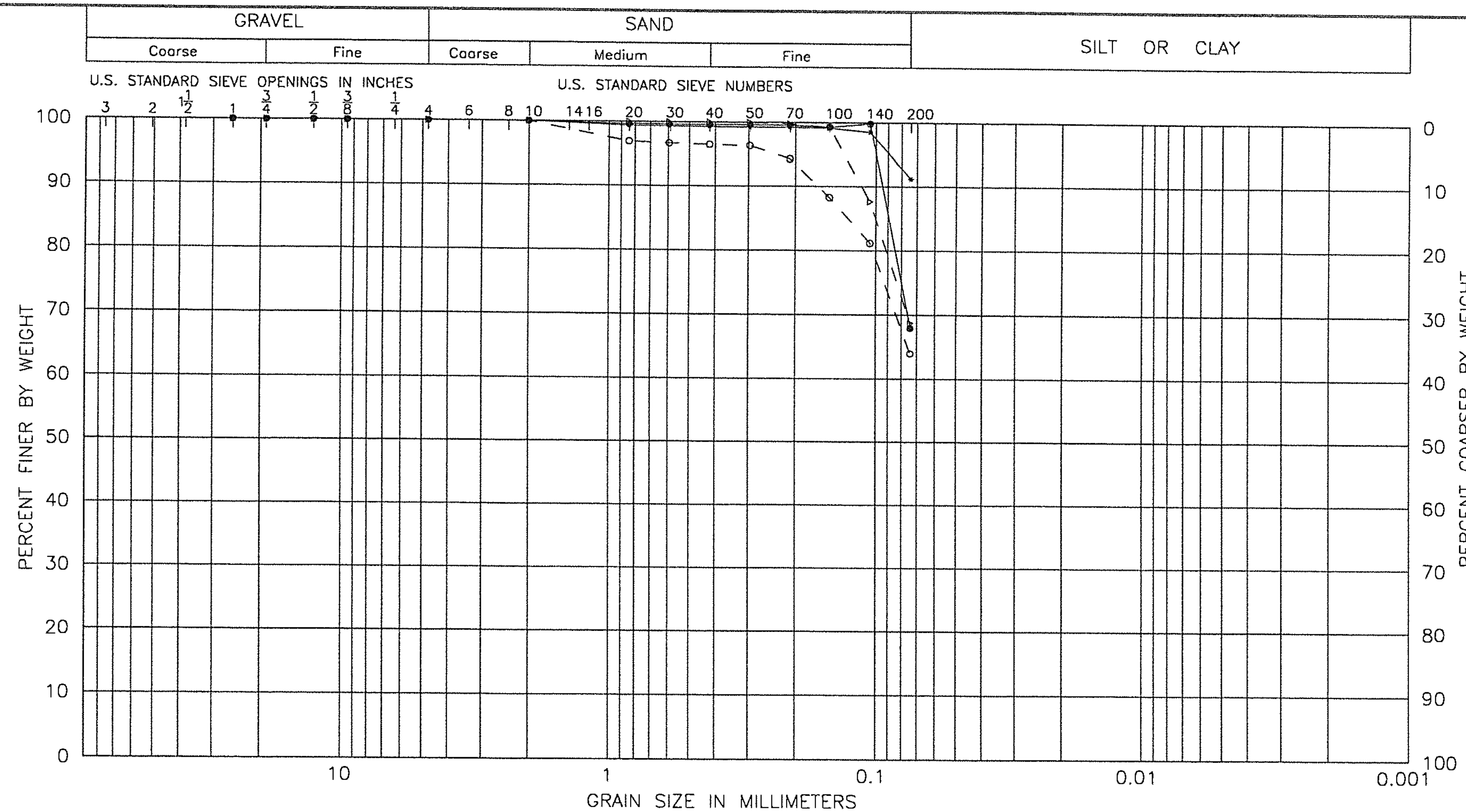
Job No. 1140194901



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●-●-●	HWB-1	S-25	46.5-48.0	Gray fine sand w/silt
○-○-○	HMB-1	S-4	4.5-6.0	Brown sandy silt w/sand and clay seams
×-×-×	HMB-1	S-17	30.5-32.0	Reddish brown and gray lean clay w/sand
▷-▷-▷	HMB-1	S-20	36.0-38.0	Reddish brown and gray silty cloy

GRAIN SIZE DISTRIBUTION CURVES

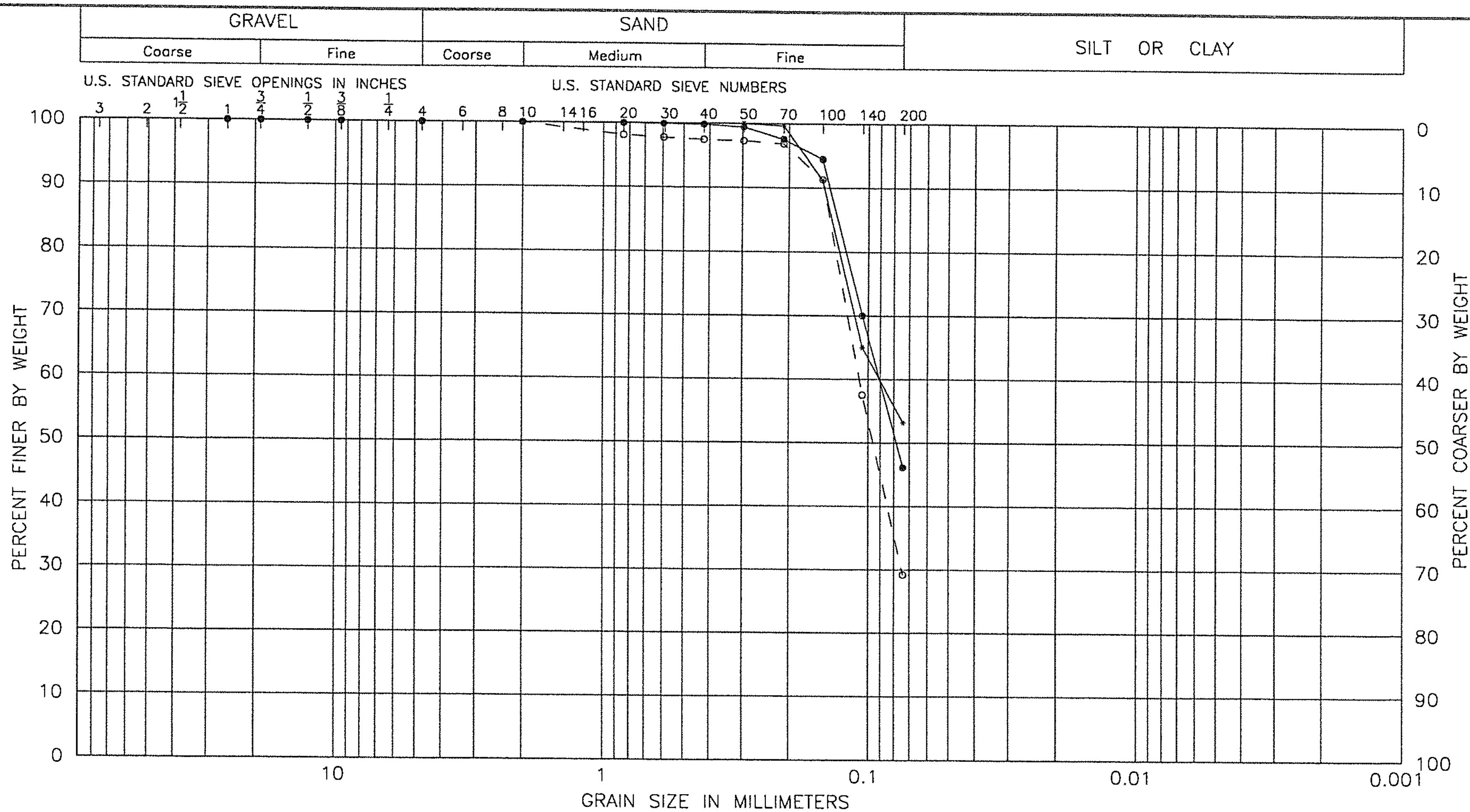
Job No. 1140194901



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●-●-●	HMB-1	S-23	42.5-44.0	Reddish brown and gray sandy silt w/clay seams
o-o-o	HMB-2	S-11	18.5-20.0	Reddish brown and gray sandy lean clay
x-x-x	HMB-4	S-12	23.5-25.0	Reddish brown silt w/clay stone
▷-▷-▷	HMB-5	S-12	20.5-22.0	Reddish brown sandy silt w/clay seams

GRAIN SIZE DISTRIBUTION CURVES

Job No. 1140194901



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●—●—●	HMB-6	S-11	23.5-25.0	Reddish brown silty sand
○-○-○	HMB-7P	S-9	16.5-18.0	Gray and brown silty sand
×—×—×	HMB-8	S-11	23.5-25.0	Brown and gray sandy silt w/clay seams

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

APPENDIX C

Piezometer Abandonment Reports

STATE OF TEXAS PLUGGING REPORT for Tracking #89207

Owner:	**Geotest Engineering, Inc**	Owner Well #:	**HMB - 1**
Address:	**5600 Bintliff Rd. Houston , TX 77036**	Grid #:	**65-12-7**
Well Location:	**Harvest Moon Houston , TX 77056**	Latitude:	**29° 45' 36" N**
Well County:	**Harris**	Longitude:	**095° 36' 00" W**
		GPS Brand Used:	**Lowrance XOG**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Dempsey Gearen Jr.**
Driller's License Number of Original Well Driller:	**2836**
Date Well Drilled:	**6/24/2013**
Well Report Tracking Number:	**333925**
Diameter of Borehole:	**5" inches**
Total Depth of Borehole:	**70' feet**

Date Well Plugged:	**8/12/2013**
Person Actually Performing Plugging Operation:	**Dempsey Gearen Jr.**
License Number of Plugging Operator:	**2836**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **2 inches diameter, From 60 ft to 70 ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in	1st Interval: **From 0 ft to 70 ft; Sack(s)/type of cement used: 3 Portland** 2nd Interval: **No Data**

Well:	3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**Dempsey Gearen Jr.** **32126 Rochen Rd.** **Waller , TX 77484**
Plug Installer License Number:	**2836**
Licensed Plug Installer Signature:	**Dempsey Gearen Jr.**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#89207**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS PLUGGING REPORT for Tracking #88931

Owner:	COH Harvest Moon	Owner Well #:	HMB-7P
Address:	Dairy Ashford Houston , TX 77077	Grid #:	66-12-7
Well Location:	1200 Dairy Ashford Houston , TX 77077	Latitude:	29° 45' 13" N
Well County:	Harris	Longitude:	096° 36' 08" W
		GPS Brand Used:	Magellan

Well Type: Monitor

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	Mario Gonzalez
Driller's License Number of Original Well Driller:	No Data
Date Well Drilled:	5/30/2013
Well Report Tracking Number:	327990
Diameter of Borehole:	5" inches
Total Depth of Borehole:	30 feet

Date Well Plugged:	7/13/2013
Person Actually Performing Plugging Operation:	Mario Gonzalez
License Number of Plugging Operator:	58171
Plugging Method:	Tremmie pipe cement from bottom to top.
Plugging Variance #:	No Data
Casing Left Data:	1st Interval: No Data 2nd Interval: No Data 3rd Interval: No Data

Cement/Bentonite Plugs Placed in Well:	1st Interval: From 0 ft to 3 ft; Sack(s)/type of cement used: Grout 2nd Interval: From 3 ft to 7 ft; Sack(s)/type of cement used: Bentonite 3rd Interval: From 7 ft to 20 ft; Sack(s)/type of cement used: Sand 4th Interval: No Data 5th Interval: No Data

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	Envirotech Drilling Services 2718 South Brompton Drive Pearland , TX 77584
Plug Installer License Number:	58171
Licensed Plug Installer Signature:	Jaime Vasquez
Registered Plug Installer Apprentice Signature:	Mario Gonzalez
Apprentice Registration Number:	No Data
Plugging Method Comments:	Amended 8/23/13 at request of driller (Plugging date from 6/30 to 7/13). Unable to use system amendment process. 8/23/13 - DT

Please include the plugging report's tracking number (Tracking #88931) on your written request.

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